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Further Studies on Some Effects of Physical Fatigue on the Peripheral Circulation of Athletes

MARIE A. HINRICHS, M.D. PH.D.
*University of Illinois Health Service**

IN A PREVIOUS study of the malarial incidence in the student population of Southern Illinois University (1), many cases of recurrent malaria were found, which were without a known history of reinfection, and in most instances, without a remote possibility of reinfection. Such recurrences could usually be ascribed to the presence of bodily conditions such as long-continued periods of physical exhaustion due to extremes of fatigue or other causes, or in some cases to episodes of debilitating bodily conditions following an infection or protracted malnutrition.

The suggestion arose that in those cases which followed fatigue, a possible explanation might be found in the peripheral circulation, more specifically in the blood cells themselves. Accordingly, experiments were devised to test the effect of prolonged vigorous fatiguing exercise upon the blood picture. It had been shown in an earlier preliminary study on forty athletes (2) that there was a significant early lymphocytosis following indulgence in exercise to the point of fatigue. The present report involves an extension of this study and includes data collected on eighty-seven more athletes as follows: complete studies on seventy-seven of these students, and supplementary studies on the other ten. Volunteer students in physical education classes and participants in several sports were asked to cooperate in submitting to the following tests; blood smears were made in the usual manner *immediately before*, and again *immediately after* fatiguing exercise and in some experiments, at several succeeding intervals throughout the recovery period following fatiguing exercise. Slides were stained with Wright's stain and buffered. The following microscopic observations and measurements were made on control and experimental slides; differential white cell count, the number of divisions of the nuclei of polymorphs, the appearance of red blood cells, and the measurement of their diameters. The physical condition of each participant was checked including examination for organic or infectious disease. The average health score for women was 81 per cent, and for men, 90 per cent. All sports except basketball and physical education classes took place out of doors. In those cases where repeated readings were

* Formerly Professor and Chairman of the Dept. of Physiology and Health Education, and Director of Health Services at Southern Illinois University.

made at intervals, the student was asked to give a complete report of his activities for the time covered by the duration of the experiment.

Data

The summarized results of the microscopic examinations of control and experimental slides are presented in the following tables. Significant changes were noted in the relative numbers and per cent of both polymorphs and total lymphocytes (see Tables 1 and 2) and in the number of nuclear lobes of the polymorphs (Tables 3 and 4). The diameters of red blood cells were measured but no significant change in size or outline of these cells was noted in these experiments.

Values for the diameters of red blood cells are necessarily not as dependable when measured in dry, stained films as they would have been had living cells been measured. However, since the results are fairly consistent and large numbers were used, it may be of interest to point out the results. The average diameters measured with an ocular micrometer ranged from 7.80 μ to 8.07 μ before exercise, and from 7.58 μ to 7.98 μ after exercise. These figures are based on the values obtained by averaging 77 x 50 cells *apiece* for control and experimental values, respectively.

It soon became evident, however, that the immediate effect of fatiguing exercise was most marked, and most reliable, when the results of fatiguing exercise were studied in their effect on the white blood cells.

In Table 1 are recorded the results of fatiguing exercise upon the relative number and per cent of polymorphs and of lymphocytes before and after exercise.

In Section I, Table 1, Column I indicates the type of activity, Column II, the number of participants in each activity, Columns III and IV, the average relative numbers of polymorphonuclear leucocytes per hundred white blood cells counted on each slide before and after exercise respectively. (Values are given in nearest whole numbers.) These averages were obtained by adding values for individual students and dividing by the number of participants—thus the number 66 (or more accurately 65.7) in Column III is 1/37th of the total number of polymorphs (2432) found in a count of 3700 white cells. Of the same 3700 white cells, 1177 were lymphocytes, large and small and the value 32 (31.9), Column VI, represents the average value of 1/37th thereof. The remaining 91 cells of the total 3700, or an average of 2.46 cells per participant, includes the types of other white cells which normally occur in normal blood smears in low percentages and in these experiments showed no change in relative frequency following exercise. Columns V and VIII show respectively the relative percentages of decrease in number of polymorphs and increase in number of lymphocytes (large and small) following each activity, while Columns VI and VII show the average relative numbers of lymphocytes per hundred white cells counted on each slide.

In Section II of Table 1 are recorded averages calculated for all controls

and all participants (87 in each case). There is a greater spread in range of values after exercise than in the controls, before exercise. This is true for both polymorphs and lymphocytes, and results are recorded in Section III of Table 1. The values for total participants in all sports show the same general trend as for individual sports.

A study of Table 1 reveals that there is a relative percentage decrease in polymorphonuclear leucocytes (Col. V) and a relative percentage increase in lymphocytes (Col. VIII) following participation in each of the various

TABLE 1

The effect of fatiguing exercise on the differential white cell count

SECTION I		POLYMORPHONUCLEAR LEUCOCYTES			TOTAL LYMPHOCYTES		
Column I	Column II	Column III	Column IV	Column V	Column VI	Column VII	Column VIII
Type of activity	Number of students	Before exercise	After exercise	Per cent decrease (Col. III–IV)	Before exercise	After exercise	Per cent increase (Col. VI)–VII)
		Aver. No. Per 100 Cells	Aver. No. Per 100 Cells		Aver. No. Per 100 Cells	Aver. No. Per 100 Cells	
Women's P.E.							
Running Games	37	66	59	—10.80	32	38	+17.00
Men's Activities							
Baseball	7	60	56	—6.67	36	41	+13.89
Football	19	69	57	—17.40	25	37	+48.00
Track	13	56	55	—1.78	41.9	42.2	+0.71
Basketball	11	66	52	—21.21	28	44	+57.14
SECTION II		Aver. of all controls	Aver. of all expts.		Aver. of all controls	Aver. of all expts.	
Total for all activities	87	64.6	56.8	—12.07	31.7	39.5	+24.6
SECTION III		Range of individual values for 87 participants					
		Before exercise		After exercise	Before exercise	After exercise	
All activities	87	32–80		31–89	14–56	11–67	

sports listed. The effect is greatest in the sports requiring long-sustained effort and continuous competitive individual performance, e.g., football and basketball. As individual competition becomes lessened and the period of individual activity shortened, the effect on the blood picture becomes less marked, as in baseball, running games, and track.

Table 2 records the individual percentage increase or decrease in values of polymorphs and lymphocytes following exercise of participants.

In Table 2, Section A, Column I lists the type of activity; Column II, the number of participants in each activity; Columns III to VII, the num-

ber of participants in each activity showing varied percentages of decrease in relative number of polymorphs after exercise. Column VIII records the number which showed neither a decrease nor an increase in relative number of polymorphs after exercise. Columns IX to XIII record the number of participants in each activity showing varied percentages of increase in relative numbers of polymorphs after exercise. Section B of Table 2 shows

TABLE 2

Range of individual values of polymorphs and lymphocytes following exercise

		PERCENTAGE DECREASE						PERCENTAGE INCREASE				
Column I	Col. II	Col. III	Col. IV	Col. V	Col. VI	Col. VII	Col. VIII	Col. IX	Col. X	Col. XI	Col. XII	Col. XIII
Activity	No. of part.	Over 30%	20–29%	10–19%	5–9%	Less than 5%	0	Less than 5%	5–9%	10–19%	20–29%	Over 30%
Section A—Polymorphs												
Women's P.E.	37	0	7	10	9	3	2	4	1	1	0	0
Baseball	7	0	0	2	2	0	2	1	0	0	0	0
Football	19	3	5	6	0	2	1	2	0	0	0	0
Track	13	2	1	2	0	1	0	2	1	1	2	1
Basketball	11	3	3	3	0	1	1	0	0	0	0	0
Totals	87	8	16	23	11	7	6	9	2	2	2	1
		58				22		7				
Per cent	100%	67%				25%		8%				
Section B—Lymphocytes												
Women's P.E.	37	1	0	1	2	2–	2	2	2	7	5	13
Baseball	7	0	0	1	1	0	0	1	1	1	0	2
Football	19	0	1	0	1	0	1	0	0	3	1	12
Track	13	1	1	3	1	1	0	1	0	1	0	4
Basketball	11	0	0	0	0	1	0	1	0	1	1	7
Totals	87	2	2	5	5	4–	3	5	3	13	7	38
		14				12–		61				
Per cent	100%	16%				14%		70%				

a tabulation of numbers of participants in each activity similarly grouped as in Section A but with reference to the values of the per cent decrease or increase of the relative number of lymphocytes following exercise.

From an examination of Table 2, it becomes evident that a total of 58, or 67 per cent, of the total number of participants showed a *significant decrease in the relative percentage of polymorphonuclear leucocytes*, and a total of 61, or 70 per cent, of the total number of participants showed a *significant increase in the relative percentage of lymphocytes.*

In Table 3 are recorded averages of nuclear divisions in polymorphs before and after exercise, and the percentage increase or decrease thereof following exercise.

In Table 3, Column I lists the type of activity, Column II, the number of participants, Columns III and IV, the average number of nuclear

TABLE 3

Average number of nuclear divisions of polymorphonuclear leucocytes

COLUMN I	COLUMN II	COLUMN III	COLUMN IV	COLUMN V
Activity	Number of participants	Average number of nuclear divisions		Per cent increase or decrease
		Before exer.	After exer.	
Women's P.E.	36	4.31	4.51	+4.87
Baseball	7	4.13	4.27	+3.39
Football	15	4.14	4.24	+2.40
Basketball	11	4.21	4.18	−0.007
Track	8	4.02	4.16	+3.48
Total	*77			

* Complete studies on only 77 slides.

TABLE 4

Range of individual values of percentage increase or decrease in the number of nuclear segments of polymorphonuclear leucocytes following exercise

ACTIVITY	NUMBER OF PARTICIPANTS	PERCENTAGE DECREASE					PERCENTAGE INCREASE			
Column I	Column II	Col. III	Col. IV	Col. V	Col. VI	Col. VII	Col. VIII	Col. IX	Col. X	Col. XI
		20%	15%	10%	5%	0	5%	10%	15%	20% or more
Women's P.E.	36	0	0	3	4	0	12	11	2	4
Baseball	7	0	1	0	0	0	3	3	0	0
Football	15	0	2	4	1	0	0	3	4	1
Basketball	11	0	1	4	0	1	1	4	0	0
Track	8	0	0	1	2	0	1	3	0	1
Totals	*77	0	4	12	7	1	17	24	6	6
		16			25		36			
Per cent	100%	21%			32%		47%			

* Complete studies on only 77 slides.

divisions before and after exercise, respectively. Column V records the percentage decrease or increase of nuclear divisions of polymorphs following exercise of participants. In each of the sports, except basketball, there was a noticeable percentage increase in nuclear lobulation of polymorphs found in the peripheral circulation following exercise.

Since the normal number of nuclear lobes is necessarily small, the occurrence of a large percentage increase or decrease after exercise is obviously impossible. Again, the range of values was greater after exercise.

Table 4 records the grouping of results according to amounts of percentage decrease or increase in number of nuclear divisions of polymorphs following exercise of participants. This Table is comparable to Table 2 in which the data for numbers and percentages of polymorphs and lymphocytes are similarly treated.

Column I of Table 4 indicates the type of activity, and Column II, the number of participants in each activity. Columns III to XI record the number of participants in each group showing varied values of percentage decrease or increase in nuclear lobulations of polymorphs. A total of 36 (Columns IX to XI) or 47 per cent of all cases showed an increase of 10 per cent or more, while 25 (Columns VI to VIII), or 32 per cent, of all cases showed either an increase or decrease of 5 per cent (or less), in the number of nuclear lobulations of polymorphs, while only a total of 16, or 21 per cent, showed a significant percentage decrease.

DISCUSSION OF DATA

These experiments have brought out further evidence that fatiguing exercise produces a noticeable effect on the peripheral circulation. The most significant change is in the relative proportions of the white cells. The effect is constant, marked, but relatively transitory. The polymorphs become relatively fewer, while there is a relative increase in the number of lymphocytes, with the effect most marked among the large lymphocytes. The effect is distinguishable shortly after fatiguing exercise, and persists for a considerable period of time, usually diminishing gradually until the normal blood picture again appears, approximately within two or three hours after exercise. There appeared to be the same trend of effect following the various types of exercise. Such an effect is comparable to that accompanying or following certain types of infection, and is sometimes referred to as an "irritation phenomenon." It represents a typical physiological lymphocytosis.

While the increase in the number of nuclear divisions of the polymorphs is not nearly as constant nor the percentage increase very large, there is a noticeable trend toward the more complete lobulation of nuclei following exercise. This suggests that since relatively fewer polymorphs are found in the peripheral blood stream following fatigue, and the nuclei of these have more divisions, younger polymorphs are not entering the peripheral circulation as fast as the old ones disappear.

The obvious effect on the red blood cells is less marked. There was no noticeable difference in either the depth of color or the uniformity of shape, and only very little effect on the size of the red blood cells. Any change in diameter of these cells could have been due to such factors as changes in the permeability of the cell wall, and are probably associated with changes in the chemistry of the plasma following fatiguing exercise.

It would have been highly desirable to include other experiments on red and white blood cells in the living state for the direct measurement of diameters, and for permeability and fragility tests, sedimentation rate studies, changes in electrical surface charges of the cells, etc., but unfortunately the experimental set-up at the time of the experiments did not permit such an extensive study.

CONCLUSIONS

1. Further evidence is presented that physical exercise to the point of fatigue produces a significant effect on peripheral circulation. This effect, though transitory, is relatively immediate.
2. The polymorphonuclear leucocytes seem to appear in relatively fewer numbers, immediately after fatiguing exercise.
3. There is a slightly greater degree of nuclear lobulation of polymorphs following fatiguing exercise.
4. There is a marked early lymphocytosis following fatiguing exercise.
5. The lymphocytosis is most marked in the sports characterized by long-sustained activity and continued competitive individual physical and mental performance, as in basketball and football.

SUMMARY

Results of studies such as the above point to the close tieup of fatigue and its effect upon the peripheral circulation. The frequency with which physical fatigue is associated with increased susceptibility to certain diseases may have a partial basis in such circulatory effects.

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Time Patterns in Motor Learning

JOHN M. HARMON, Ed. D., *Chairman*
ARTHUR G. MILLER, Ed. D., *Assistant Professor*
Boston University, School of Education, Research Laboratory in Physical Education

THE major objective of this research is to find a basis for improvement in methods of teaching. Teachers have been quite subjective in determining the frequency of practices in the teaching of motor skills or other school subjects. Only a few research efforts have been reported on the subject of time psychology. The old adage "practice makes perfect" seems to have much less meaning in the light of present research. The length of time intervals between practice periods may prove to be just as important as the length of practice periods.

The unique phase of this research is the inclusion of a time pattern that has not been used in other research, and which is found significantly more advantageous than the other three patterns used. The unique time pattern is herein called the additive pattern. It should be noted that this pattern follows a five-eight ratio and is suggested or borrowed from the field of botany. The relationship to botany is through philotaxy, which is a law of growth of plants involving a five-eight ratio.

More and more psychologists are concluding that the learning process is a neurological growth process, therefore, more research should be encouraged in which the known laws of growth, or related factors, are applied to learning situations. In the opinion of the authors, the field of physical education offers excellent laboratories for research in which major contributions may be made that are important to all fields of education, and especially in studies of the learning process.

This research is upon the level of basic or beginning skills, in which problems of reliability of performance may be solved or better understood. One follow-up study herein reported by Lawrence (11) indicates that reliability may be determined, at least in part, by the time pattern upon which basic or beginning skills are learned.

Other research is going forward in which studies are being made of the most efficient time patterns for coaching the various sports. In other words, how long are optimum practice periods in various sports and upon what days of the week in relation to scheduled contest? Such questions may possibly be answered through experimental research in time psychology.

EXPERIMENT IN TIME PSYCHOLOGY

Physical education includes many skills which lend themselves to research in the field of time psychology due to the fact that they can be

isolated, controlled and evaluated while maintaining the interest of the subjects.

Billiards was used as the motor skill to be learned because set shots could be standardized for use by all subjects, the table could be made available to all participants and an interest created and maintained in the experiment.

College women who had had no previous experience in playing pool or billiards were used as subjects for the experiment. The players were divided into four groups. The units of practice, number of practices and length of practice periods were kept constant for all groups. The time intervals between the practice periods were varied for each of the four groups and produced the following time patterns:

1. The first group carried on their nine practice sessions three days per week for three weeks in a row—i.e., Monday, Tuesday, Wednesday of the first week, Monday, Tuesday, Wednesday of the second week and Monday, Tuesday, Wednesday of the third week. Listing the days by numbers gives the following practice days: 1st day, 2nd, 3rd, 8th, 9th, 10th, 15th, 16th, 17th. This group was called the *Three-Day-Per-Week-Group.*

2. The second group carried on their practice periods on an additive basis—i.e., adding the first two numbers or days to make the third number or day (first day plus second day equals third day); the second and third numbers or days to make the fourth number or day, etc., up to and including the fifty-fifth day which was the ninth practice session. Listing the nine practice periods by numbers, gives days on which the practices occurred: 1st day, 2nd, 3rd, 5th, 8th, 13th, 21st, 34th, 55th. This group was called the *Additive-Group.*

3. Practice for the next group was conducted on a daily basis including Saturday and Sunday. The time pattern may be described as follows: 1st day, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th. This group was called the *Daily-Group.* From a relative point of view this group most nearly approached massed learning as far as this experiment was concerned.

4. The last time pattern was established on the basis of practice once per week. The number of the nine respective days when the practice periods were conducted include: 1st day, 6th, 15th, 22nd, 29th, 36th, 43rd, *, 57th, 64th. The exception (*) to the one day per week schedule was made between the seventh and eighth practice periods because of vacation week. The group was called the *One-Day-Per-Week-Group.*

A group of set shots were developed by the authors and tried out by two women subjects who had never played billiards or pool. During this testing period, which was conducted over a period of two months, eleven set shots were established and arranged more or less progressively in their order of difficulty. The first five of the eleven set shots were then selected for the first practice period. Number one set shot was attempted five times on the right side of the table. The same set shot was repeated on the left side of the table. This procedure was carried on with set shots two, three, four, and five, thus making a total of fifty shots per practice period. During each

succeeding practice period, a new shot was added while dropping the first set shot of the previous practice. This procedure was carried on until all eleven set shots were used.

One exception to this procedure was the retention of one set shot for all practice periods. A constant was thus provided to show the effect of time on learning a single set shot.

The first practice period was used for instruction. Starting with the second practice period and continuing on throughout the ninth practice session, no corrective suggestions were given.

ANALYSIS OF THE DATA

The scores from the second practice period were selected as the basis for equating the four groups. These scores are presented in Tables 1 and 2.

TABLE 1

Summary of the data for the second practice period for the four groups

GROUPS	NUMBER	RANGES	MEANS	S.D.
I—Three day per week.....	18	19–41	29.2	6.96
II—Additive.....	18	20–40	29.1	6.85
III—Daily.....	18	17–43	29.3	7.41
IV—One day per week.....	18	18–42	29.2	6.92

TABLE 2

Correlation coefficients between groups

GROUPS	CORRELATION COEFFICIENTS	GROUPS	CORRELATION COEFFICIENTS
I–II	0.986	II–III	0.955
I–III	0.981	II–IV	0.955
I–IV	0.973	III–IV	0.989

At the end of the experiment the statistical differences between the four groups were determined. A critical ratio of 2.50 (approximately the 1% level) was considered indicative of a statistically significant difference. Table 3 shows the differences in the mean scores for the four groups for the last practice period.

1. The results of the three consecutive days per week pattern (group I) were inferior to those of the additive pattern. However, it produced better results than the daily and the one day per week patterns, respectively, but the differences were not statistically significant.

2. The additive time interval pattern (group II) produced the best results. There were statistically significant differences in the mean gains and resulting critical ratios of this group over those of the other three groups.

3. The results of the daily time pattern (group III) were better (but not

statistically significantly better) than those for the one day per week time pattern (group IV) but inferior to the results of the other two patterns.

4. The one day per week pattern (group IV) proved to be the poorest of the four patterns.

5. The results of the one set shot which was used in all practice periods for the four groups were similar to the results of all set shots for the groups. In other words, as far as results were concerned, the research might have been limited to one set shot for all four groups.

TABLE 3

Difference in means between the four groups for the ninth practice period

GROUP PRACTICE	NO.	M	S.E.	Dmlm2	S. E.d	C. R.
I	18	31.6	1.26	3.0	1.20	2.50
II	18	34.6	0.88			
I	18	31.6	1.26	1.0	1.50	0.66
III	18	30.6	1.33			
I	18	31.6	1.26	2.0	1.56	1.28
IV	18	29.6	1.06			
II	18	34.6	0.88	4.0	1.48	2.71
III	18	30.6	1.33			
II	18	34.6	0.88	5.0	1.38	3.63
IV	18	29.6	1.06			
III	18	30.6	1.33	1.0	1.47	0.68
IV	18	29.6	1.06			

CONCLUSIONS

1. There were no statistically significant differences between the patterns through the sixth practice period. Significant differences thereafter occurred and were probably due to the various time patterns used from the beginning of the experiment. Therefore, in conducting research in this field, practices should be carried on beyond six practice periods.

2. There were no statistically significant differences in the final results between the nine consecutive days pattern, the three consecutive days per week for three weeks pattern and the pattern of one day per week for nine weeks.

3. There were statistically significant differences in the final results in favor of the additive pattern over the other three patterns.

4. A good base or foundation should be established in learning a new skill such as billiards. Relative massing at the beginning of the learning process is to be preferred over widely spaced time intervals at the beginning. From three to five practice periods were found satisfactory for establishing beginning skills.

5. After the foundation has been laid, greater spacing between practice periods has a more favorable effect upon learning than continued massing.

6. Progressively lengthening the time intervals between the practice periods (the additive pattern) proved beneficial in learning a new motor skill. The additive pattern may not be the best time pattern to be used in learning, but should be considered as a point of reference from which further research may be undertaken in finding such a pattern.

FURTHER RESEARCH

In a follow-up study Longley (12) used a "Massed-evenly spaced" time pattern (1, 2, 3, 8, 15, 22, 29, 36, 43) which, when compared with Miller's (15) four time patterns gave the following results:

The improvement of the "Massed-evenly spaced" group (Longley's) was slightly inferior to the Additive group (Miller's group II), although the result was not statistically significant. There were statistically significant differences in favor of the "Massed-evenly spaced" group over Miller's other three groups—i.e., Daily group, Three day per week group, and One day per week group. These results were similar to the Additive-Group's statistically significant superiority over the other three groups.

The results of these two studies seem to indicate that some form of a massed spaced time pattern should be used in learning a new motor skill.

Lawrence (11), using over sixty per cent of the subjects used in the original study, made a reliability check of the Additive group (Miller's group II) and the Daily group (Miller's group III). The check was to be considered indicative of the degree of retention between the two groups.

The results of the study showed a statistical significance (a critical ratio of 2.87) in favor of the Additive group over the Daily group.

A conclusion which may be drawn from this study is that the retention in a massed-interpolated-spaced learning pattern (Additive group) was superior to the retention in a massed learning pattern (Daily group). Further research should be conducted before any final conclusions may be made as all of the original subjects were not used in the reliability check.

There are many unsolved problems in the field of time psychology, some of which are now in the process of being solved by other research workers.

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The Effect of Systematic Weight Training on Athletic Power

EDWARD CHUI
University of Hawaii
Honolulu, T. H.

MANY PEOPLE, including those directly as well as those indirectly related to physical education and athletics, believe that weight training may be detrimental to the participant. Very frequently, in the classroom, on the gymnasium floor, and on the athletic field, the term "weight training" is associated with "muscle-boundness," a condition supposedly resulting in a general slowing down of the contraction speed of the muscular system. No scientific evidence, however, has been advanced to support these beliefs. This study was undertaken to ascertain some of the pertinent facts concerning the effects of systematic weight training on athletic power.

Weight training, as considered in this treatise, refers to a systematic, well-planned program of exercises in which the participant uses weights, barbells and dumbbells, to increase the resistance of various bodily movements. This type of exercise with weights is contrasted with the competitive type usually referred to as "weight lifting." In weight lifting the competitor endeavors to raise a maximum weight in a single lift, whereas in weight training the participant executes many consecutive repetitions of each exercise with a weight which has been found to be compatible with his strength and endurance. In competition, there are only three prescribed lifts, the Olympic lifts, namely, the "Press," the "Snatch," and the "Clean and Jerk." In weight training, the exercises and the weights are selected in accordance with the participant's objective, and in accordance with his present strength and endurance.

Experimental Procedure

Subjects. Two groups of subjects were used in this study. One group of twenty-three subjects performed the weight training exercises, which are outlined below, two to three times a week for one hour each period. This group of subjects will be referred to hereafter as Group A. The other group, which was composed of twenty-two subjects, did no weight training exercises, but participated in the required physical-education program of the State University of Iowa. This latter group of subjects will be referred to hereafter as Group B. The subjects of Group A were students who had engaged in very little or no weight training up to the time of this experi-

ment, and ranged in age from seventeen to thirty-two years. The subjects of Group B were freshmen and sophomores from seventeen to nineteen years of age.

Data

The following data were secured from both groups at the beginning and at the end of the three-month training period:

1. Body weight
2. Sargent jump—standing
3. Sargent jump—running
4. Standing broad jump
5. Eight-pound shot-put from a stand
6. Twelve-pound shot-put from a stand
7. Sixty-yard sprint

Each subject was given individual instruction in the various tests, and practiced until he could perform the tests to the satisfaction of the experimenter. The test items were administered to each subject on three different days, and the best performance in each test was taken as the record in each event. The body weight was recorded on the first test day. This plan was followed during the initial test and also during the final test at the end of the three-month period. All the subjects were instructed not to practice these test items during the three-month period.

The inclusion of these six performance tests in the testing criterion was based on the thesis that power (the time rate of doing work, or, force times velocity), when applied by the human body, is the essential mechanical factor in the projection of the individual's own body or of some other mass rapidly through space. All these events—sprinting, jumping, and throwing—require maximum, or nearly maximum, muscle contractions in a minimum of time, and have been well substantiated as valid test items for measuring power (2, 4).

Weight Training Exercises. The following exercises were employed in this study (1):

Barbell Exercises

1. High pull-up
2. Two-arm curl
3. Side bend
4. Two-arm press
5. Repetition snatch
6. Stiff leg dead lift
7. Supine press
8. Straddle hop
9. Repetition clean and jerk
10. Squat (alternated with squat jump)

Dumbbell Exercises

1. Squat jump (alternated with squat)
2. Forward raise
3. Pull-over
4. (a) Lateral raise (standing)
   (b) Lateral raise (trunk bent forward)
5. Supine lateral raise
6. Sit-up

The subjects individually followed this plan of exercise. Each exercise was performed from eight to twelve repetitions. The sit-up exercise was performed from fifteen to twenty-five repetitions. Each individual subject used a weight with which he could correctly perform the exercise eight times and continued using this weight until he could do twelve repetitions without undue distress. Then the weight was increased and the eight-to-twelve repetition plan was repeated. In the exercises with the barbell, one weight (in general, about 70 pounds) was used for exercises 1, 2, and 3. A second, heavier weight (in general, about 100 pounds) was used for exercises 4, 5, and 6. A third, heavier weight (in general, about 125 pounds) was used for exercises 7, 8, 9, and 10. Some individuals were able to use a heavier weight for exercise 10 than that which was used for exercises 7, 8, and 9. In the exercises with the dumbbells, the weight used (in general, about 15 pounds) was the same for all five exercises. There were a few individuals who were able to use a dumbbell heavier by about five pounds for exercise 2. In the sit-up exercise, a weight was used for 15 repetitions and was not increased until 25 repetitions could be performed. In general, the subjects used from 5 to 20 pounds in this exercise.

RESULTS

The data obtained from the subjects of both groups are summarized in the following tables. The figures presented in Tables 2–7 would seem to the writer to justify the statements made following the appropriate tables, concerning the effects of systematic weight training on athletic power.

Power as Related to Jumping. The results of the standing Sargent jump test showed that the mean improvement was 7.2 cm.[1] The gains varied from 1 cm. to 12 cm. All the subjects showed an improvement in this test.

The results of the running Sargent jump test showed an average improvement of 7.6 cm. The range in improvement varied from 1 cm. to 14 cm. Twenty-two subjects showed gains and one subject showed no difference.

The results of the standing broad jump test showed an average improvement of .3 of a foot. However, of the twenty-three subjects tested, twenty-one showed an improvement ranging from ½ inch up to 10¼ inches, while one subject showed a loss of 1 inch and one subject showed a loss of 2½

[1] The figures used here in the discussion of the findings together with the implications drawn from them, all refer to Group A. There was no significant improvement in Group B.

TABLE 1

Body weight (pounds)

GROUP A		GROUP B	
Means of body weights		Means of body weights	
Initial test	157.3	Initial test	146.8
Final test	160	Final test	149
Mean of gains among those who gained weight	4.5	Mean of gains among those who gained weight	3.8
Mean of losses among those who lost weight	2.2	Mean of losses among those who lost weight	2.5

The differences or changes recorded in body weight ranged from a gain of 13 pounds to a loss of 4 pounds for Group A, and from a gain of 7 pounds to a loss of 3 pounds for Group B.

TABLE 2

Sargent Jump—standing (centimeters)

GROUP A		GROUP B	
Means of jumps		Means of jumps	
Initial test	52.4	Initial test	53.36
Final test	59.6	Final test	53.26
Mean of gains among those who gained	7.2	Mean of gains among those who gained	3.86
No losses were recorded		Mean of losses among those who lost	2.14

The difference in performances recorded for each subject ranged from a gain of 1 to 12 centimeters for Group A, and from a gain of 8 centimeters to a loss of 4 centimeters for Group B.

TABLE 3

Sargent Jump—running (centimeters)

GROUP A		GROUP B	
Means of jumps		Means of jumps	
Initial test	56	Initial test	56.9
Final test	63.6	Final test	55.9
Mean of gains among those who gained	8	Mean of gains among those who gained	2.88
No losses were recorded		Mean of losses among those who lost	3.18

The difference in performances recorded for each subject ranged from no difference to a gain of 14 centimeters for Group A, and from a gain of 8 centimeters to a loss of 7 centimeters for Group B.

inches. Among the twenty-one subjects who did show an improvement, the mean improvement was 3.99 inches.

TABLE 4

Standing Broad Jump (feet and inches)

GROUP A		GROUP B	
Means of jumps		Means of jumps	
Initial test	7.5 ft.	Initial test	7.15 ft.
Final test	7.8 ft.	Final test	7.14 ft.
Mean of gains among those who gained	3.99 in.	Mean of gains among those who gained	2.375 in.
Mean of losses among those who lost	1.75 in.	Mean of losses among those who lost	2.885 in.

The difference in performances recorded for each subject ranged from a gain of 10.25 inches to a loss of 2.5 inches for Group A, and from a gain of 4.25 inches to a loss of 7 inches for Group B.

TABLE 5

Eight-pound Shot-Put (feet and inches)

GROUP A		GROUP B	
Means of puts		Means of puts	
Initial test	33.33 ft.	Initial test	31.184 ft.
Final test	36.32 ft.	Final test	31.6 ft
Mean of gains among those who gained	2.98 ft.	Mean of gains among those who gained	2.23 ft.
No losses were recorded		Mean of losses among those who lost	1.91 ft.

The difference in performances recorded for each subject ranged from a gain of 5 feet ¾ inch to 1 foot 1¾ inches for Group A, and from a gain of 5 feet 11 inches to a loss of 5 feet 10 inches for Group B.

TABLE 6

Twelve-pound Shot-Put (feet and inches)

GROUP A		GROUP B	
Means of puts		Means of puts	
Initial test	27.18 ft	Initial test	25.12 ft.
Final test	29.5 ft.	Final test	25.7 ft.
Mean of gains among those who gained	2.37 ft.	Mean of gains among those who gained	1.41 ft.
No losses were recorded		Mean of losses among those who lost	10.34 in.

The difference in performances recorded for each subject ranged from a gain of 6 inches to 4 feet 9¾ inches for Group A, and from a gain of 3 feet 5 inches to a loss of 2 feet for Group B.

The data obtained from these jumping tests indicate that systematic weight training as outlined in this study has a decidedly positive effect on jumping power.

Power as Related to the Shot-Put. The results of the eight-pound shot-put test showed a mean improvement of 2.98 feet or 2 feet $11\frac{3}{4}$ inches.[2] The gains varied from 1 foot $1\frac{3}{4}$ inches to 5 feet $\frac{3}{4}$ inch. All of the subjects tested showed an improvement.

The results of the twelve-pound shot-put test were similar to those of the eight-pound shot-put test. The mean improvement was 2.37 feet or 2 feet $4\frac{1}{2}$ inches, with the gains varying from 6 inches to 4 feet $9\frac{3}{4}$ inches. All of the subjects tested showed an improvement.

The data obtained from these shot-put tests show that systematic weight training as outlined in this study has a positive effect on power involved in the shot-put.

Power as Related to Sprinting. The results of the sixty-yard dash showed that of the twenty-two subjects tested, seventeen showed an improvement, four showed no difference, and one ran slower by 0.1 of a second.[3] Of the seventeen who ran faster, the mean improvement was 0.33 of a second, with the gains in speed varying from 0.1 of a second to 0.6 of a second.

TABLE 7

Sixty-yard Dash (seconds)

GROUP A		GROUP B	
Means of times		Means of times	
Initial test	7.9	Initial test	8.05
Final test	7.57	Final test	8.1
Mean of gains in speed among those who ran faster	0.33	Mean of gains in speed among those who ran faster	0.16
Loss in speed for one subject who ran slower	0.1	Mean of losses in speed among those who ran slower	0.18

The difference in performances recorded for each subject ranged from a gain of 0.6 of a second to a loss of 0.1 of a second for Group A, and from a gain of 0.2 of a second to a loss of 0.4 of a second for Group B.

These results indicate the probability of increasing speed through training with systematic weight training exercises.

GENERAL INDICATIONS

The data obtained from this study and the implications drawn from the data indicate that the subjects of Group A seemed to increase the amount of potential power through systematic weight training exercises, whereas,

[2] The figures used here in the discussion of the findings together with the implications drawn from them, all refer to Group A. There was no significant improvement in Group B.

[3] The figures used here in the discussion of the findings together with the implications drawn from them, all refer to Group A. There was no significant improvement found in Group B.

the subjects of Group B did not show such consistent increases. Power, being force times velocity, in the human body is apparently limited by the muscular viscosity (3). The greater the speed of contraction, the more force is required to overcome the viscosity of the muscles. With an increase in strength, however, more force can be used to overcome the viscosity of the muscle, and to force the maximum velocity to higher levels.

This study concerned itself solely with the effect of weight training on athletic power, and no data were presented relating to improvements in actual strength, in muscular endurance, or in circulorespiratory endurance.

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Extra Pay for Extra Services

JOHN H. SHAW
Syracuse University

and

GEORGE H. KRABLIN
St. Lawrence University

WHAT is the present policy and practice regarding compensation for extra services in the high schools of New York State? To discover the answer to this question a questionnaire was sent to all city superintendents, village superintendents and to all central school principals[1] in the State. It is hoped that the findings will be of help to the schools in New York State and other states which have not yet set up such policies and practices or who are planning to revise their present system.

Fifty-two[2] replies were received from the 62 city superintendents, 76 from the 100 village superintendents and 279 from the 346 central schools. This represents a return of 84, 76 and 81 per cent respectively.

The following questions were asked:

1. What is the policy of your school (or school system) with regard to compensation for extra services? *Check correct answer*
   (1) Load compensation—no salary differential .....
   (2) Extra pay schedule for extra services .....
   (3) Included in basic salary (e.g. regular salary for other teachers, $2400, for physical education teachers $2800) .....
   (4) No pay or load differential .....
   (5) Others (please explain) .....

   Please enclose copy of policy and/or pay schedule if available

2. If there is extra pay what is the source?
   (1) Board of Education funds .....
   (2) Athletic Fund (gate receipts) .....
   (3) Others (list and explain—e.g. receipts from school play) .....

[1] City and village superintendencies are difficult to define adequately. The cities are such by their charter and in general are larger than villages although there is considerable overlap. A village superintendency is a superintendency in a village of over 4500 population as determined by the Commissioner of Education. Village lines and village superintendencies may or may not coincide. Central School Districts can be compared to consolidated schools in other states.

[2] Only 50 answers in this group actually were tabulated due to inadequately filled out questionnaires in two cases. Therefore 50 will be used instead of 52 in the rest of the study.

3. Supervision of which school activities carry extra pay? *Insert amount of yearly compensation below*

(1) Club activities (e.g. dramatics, band, yearbook—list names below) .....

.....

(2) Intramurals .....
(3) Interscholastic sports (list below) .....
(4) Other activities (list as in the above) .....

.....

4. Please add here any information not already listed that will help us to understand more fully your system of compensation for extra services.

Chart I is a summary of the answers received to the first question—what is the policy of your school, or school system, with regard to compensation for extra services? With a few exceptions the answers indicated

CHART I

School policy regarding compensation for extra services

	CITY SUPERINTENDENTS	VILLAGE SUPERINTENDENTS	CENTRAL SCHOOLS ADMINISTRATORS	TOTAL OF THREE GROUPS
	50 (total answering)	76 (total answering)	279 (total answering)	405 (total answering)
(1) Load compensation—no salary differential	6 (12%)	6 (8%)	57 (20%)	69 (16%)
(2) Extra pay schedules for extra services	21 (42%)	29 (38%)	32 (11%)	82 (20%)
(3) Included in basic salary	5 (10%)	13 (17%)	98 (35%)	116 (28%)
(4) No pay or load compensation	4 (8%)	7 (9%)	52 (19%)	63 (16%)
(5) Some combination of the above four	14 (28%)	21 (28%)	40 (15%)	75 (19%)

clearly the policies of the individual schools. The superintendent of one city school indicated a combination of load compensation—no salary differential and no pay or load differential! The only plausible explanation for this seeming inconsistency is that some people are treated in a different manner than others revealing that there is no real policy except one of expediency.

A few village superintendents also indicated incompatible combination policies. In at least one instance this was explained by a transition from one policy to another in regard to extra pay. As the new policy was not made retroactive a temporary dichotomy of practice exists. There were also a few apparent inconsistencies in the policies reported by the central school principals.

The one striking difference in policy discovered in the study was that city and village schools in New York State are much more likely to have extra pay schedules for extra services than are central schools—42 and 38 per cent respectively as compared to 11 per cent. Conversely, central schools are much more likely to include extra pay for extra services in the

basic salary—35 per cent as compared to 10 and 17 per cent for the city and village superintendents.

Chart II is a summary of the answers received to the second question—If there is extra pay what is the source?

Some very interesting and unusual extra pay for extra duty items appear in Chart IV. A few of these and the salary increment provided yearly are:

Detention Master	$175
Cheerleader Director	$75–$150
Alumni and Former Student Relations	$100
Bus Starter	$100–$200
Head of Family with Dependents	$500

CHART II

Source of extra pay

	CITY SUPERINTENDENTS	VILLAGE SUPERINTENDENTS	CENTRAL SCHOOL ADMINISTRATORS	TOTAL OF THREE GROUPS ANSWERING
	36 (total answering)	49 (total answering)	80 (total answering)	165 (total answering)
(1) Board of Education Funds	33 (91%)	48 (98%)	75 (94%)	156 (94%)*
(2) Athletic Fund (gate receipts)	1 (3%)	1 (2%)	1 (1%)	3 (2%)
(3) Others (list and explain—e.g. receipts from school play)				
Combination of (1) and (2)	2 (6%)		3 (4%)	5 (3%)
City recreation funds			1 (1%)	1 (1%)

* Because of the very large number of schools returning questionnaires without answering this question (64%) the results may not represent the actual situation in the schools of the state as a whole.

Two items of interest gleaned from the answers to question four—any additional information that would help in understanding a particular school's system of compensation for extra service—were:

(1) Several schools mentioned that they were paying extra for junior high school sport coaching although no such break down was requested in the questionnaire.

(2) One school stated that it paid a flat $2.50 per hour for services beyond a normal load (normal load was defined as 5 classes daily plus 75 hours extra-curricular work for academic teachers, 5 classes plus 200 hours for art, music and shop teachers, and 5 classes plus 350 hours of extra curricular activities for physical education teachers!).

(3) One village school indicated a policy of granting a family allowance and stated that extra services had been volunteered by the recipients of these benefits.

CHART III

Range and median of extra pay reported for various activities

	CITY SUPERINTENDENTS (50 TOTAL ANSWERING)		VILLAGE SUPERINTENDENTS (76 TOTAL ANSWERING)		CENTRAL SCHOOL ADMINISTRATORS (279 TOTAL ANSWERING)		TOTAL OF THREE GROUPS (405 TOTAL)	
	Number reporting extra pay for this activity	Salary reported (median indicated below range)	Number reporting extra pay for this activity	Salary reported (median indicated below range)	Number reporting extra pay for this activity	Salary reported (median indicated below range)	Number reporting	Salary range (median indicated below range)
1. Athletic administration (director, accounts, equipment, game and ticket managers)	11 (22%)	$100–900 Median 325	7 (9%)	$4.00 per game –250 annual Median 150	7 (3%)	$50–300 Median 200	25 (6%)	$4.00 per game –900 annual Median 225
2. Baseball (head-coach, assistant, junior varsity and freshman)	33 (66%)	$2.00 per hour –350 annual Median 200	33 (43%)	$100–300 Median 200	35 (13%)	$75–300 Median 150	101 (25%)	$2.00 per hour –$350 annual Median 200
3. Basketball	44 (88%)	$100–750 Median 300	38 (50%)	$100–500 (1 listed $100 for coaching women's basketball) Median 200	51 (18%)	$100–400 Median 200	133 (33%)	$100–750 Median 250
4. Bowling	3 (6%)	$50–100 Median 100	6 (8%)	$50–150 Median 100	5 (2%)	$100–150 Median 150	14 (3%)	$50–150 Median 100
5. Coaching (general or several sports listed e.g. minor sports, football, baseball and track	4 (8%)	$100–800 Median 600	15 (20%)	$100–800 Median 300	26 (9%)	$50–900 Median 300	45 (11%)	$50–900 Median 300
6. Cross Country	5 (10%)	$50–150 Median 125	5 (7%)	$100–150 Median 125	4 (1%)	$100–175 Median 150	14 (3%)	$50–175 Median 135
7. Dramatics (also includes debate and public speaking	8 (16%)* 4 (8%)†	$100–300 Median 200 $25–100 (per play) Median 75	6 (8%) 1 (1%)	$50–200 Median 100 $75	11 (4%) 2 (0.7%)	$50–500 Median 100 $50–100 Median 85	25 (6%) 7 (2%)	$50–500 Median 100 $25–100 Median 75
8. Extra Curricular	3 (6%)	$200	1 (1%)	$150	7 (3%)	$100–300 Median 150	11 (3%)	$100–300 Median 200

		Median 75				Median 85		Median 75
8. Extra Curricular Activities, (social, general organization service squads, assemblies)	3 (6%)	$200	1 (1%)	$150	7 (3%)	$100–300 Median 150	11 (3%)	$100–300 Median 200
9. Football (head, junior varsity, assistant, freshman and touch football coach)	50 (100%)	$125–1500 Median 300	46 (61%)	$100–700 Median 200	35 (13%)	$75–700 Median 185	131 (32%)	$75–1500 Median 250
10. Golf	5 (10%)	$50–125 Median 100	6 (8%)	$50–100 Median 100	4 (1%)	$50–175 Median 135	15 (4%)	$50–175 Median 100
11. Hockey:	2 (4%)	$100–300	2 (3%)	$100–250			4 (1%)	$100–300 Median 175
Ice								
Field (Women)			1 (1%)	$100			1 (0.2%)	$100
12. Intramurals (including noon time recreation, play grounds, and scouts—both boys & girls)	20 (40%)	$1.25 per hour –400 annual Median 165	12 (16%)	$2.00 per hour –475 annual (1 listed 100 per sport) Median 200	12 (4%)	$100–250 Median 100	44 (13%)	$1.25 per hour–475 annual Median 150
13. Lacrosse (head, assistant, junior varsity and freshman coach)			6 (8%)	$100–350 Median 150			6 (1%)	$100–350 Median 150
14. Music Activities (band, orchestra, instrumental, choral and combinations)	8 (16%)	$50–500 Median 200	5 (7%)	$200–500 Median 200	14 (5%)	$60–600 Median 200	27 (7%)	$50–600 Median 200
15. Publications (paper and yearbook)	14 (28%)	$75–200 Median 100	24 (32%)	$50–300 Median 125	23 (8%)	$75–350 Median 150	61 (15%)	$50–350 Median 100
16. Rifle			3 (4%)	$100 Median 100	2 (0.7%)	$100–300	5 (1%)	$100–300 Median 100
17. Skiing	1 (2%)	$75					1 (0.2%)	$75
18. Soccer (head, assistant, junior varsity and freshman)	3 (6%)	$50–250 Median 200	8 (11%)	$100–250 Median 175	8 (3%)	$100–225 Median 150	19 (5%)	$50–250 Median 175

CHART III—*Continued*

	CITY SUPERINTENDENTS (50 TOTAL ANSWERING)		VILLAGE SUPERINTENDENTS (76 TOTAL ANSWERING)		CENTRAL SCHOOL ADMINISTRATORS (279 TOTAL ANSWERING)		TOTAL OF THREE GROUPS (405 TOTAL)	
	Number reporting extra pay for this activity	Salary reported median indicated below range)	Number reporting extra pay for this activity	Salary reported (median indicated below range)	Number reporting extra pay for this activity	Salary reported (median indicated below range)	Number reporting	Salary range (median indicated below range)
19. Softball			1 (1%)	$150	1 (0.4%)	$100	2 (0.5%)	$100–150
20. Supervision of Special Events (ticket sellers and takers, announcers, stage attendants, assistant ticket manager, auditorium director)	5 (10%)	$2.00 per event–200 annual Median 200 (4 paid by event)	6 (8%)	$2.00 per hour–300 annual Median 290 (4 paid by event)	5 (2%)	$2.00 per hour–250 annual Median 200 (2 paid by event)	16 (4%)	$2.00 per hour–300 annual Median 225 (10 paid by event)
21. Swimming (head and assistant coach)	9 (18%)	$100–300 Median 185	1 (1%)	$100	1 (0.4%)	$275	11 (3%)	$100–300 Median 185
22. Tennis	10 (20%)	$50–150 Median 100	10 (13%)	$50–300 Median 100	8 (3%)	$50–200 Median 100	28 (7%)	$50–300 Median 100
23. Track (head, assistant, junior varsity and freshman coach)	35 (70%)	$50–350 Median 200	23 (30%)	$100–250 Median 200	18 (6%)	$50–200 Median 150	76 (19%)	$50–350 Median 200
24. Wrestling	2 (4%)	$100–200 Median 150	3 (4%)	$100–150 Median 100	4 (1%)	$100–300 Median 225	9 (2%)	$100–300 Median 150

* Number and salaries reported on yearly basis.
† Number and salaries reported per play.

This study did not attempt to establish what is desirable policy or practice but the authors are convinced that teaching services should not be contracted for piecemeal and that negotiations should be on the basis of arriving at a salary which covers all the duties of a particular teacher. *This should not be interpreted to mean that extra duties should be added to a teachers load without an increase in base pay or that certain teachers should have greater responsibilities without added remuneration.*

CHART IV

*Miscellaneous Headings**

	NUMBER REPORTING	SALARY RANGE AND MEDIAN
1. Administration (general) head of department, secondary school vice principal, assistant to the principal	16 (4%)	$100–1200 Median 200
2. Attendance (census)	6 (1%)	$100–200 Median 100
3. Cafeteria (manager-cashier)	5 (1%)	$100–200 Median 200
4. Fund administrator (treasurer extra funds, controller, extra class funds, fund auditor)	27 (7%)	$50–600 Median 150
5. Advisors (class, club)	32 (8%)	$25–250 Median 100
6. Guidance and Counseling	6 (1%)	$100–500 Median 225
7. Head of family with dependents	1 (0.2%)	$500
8. Services (book store, shop maintenance, lab maintenance, work on athletic field, art department services, bus starter or driver)	15 (4%)	$84–700 (some listed hourly pay rate) Median 125
9. Special jobs (alumni and former student relations, testing, detention master, cheerleaders, morning study hall, photography)	8 (2%)	$75–400 (some listed hourly pay rate) Median 150
10. Special teaching (industrial arts, girls physical education, driver training, agricultural supervision and agricultural projects)	9 (2%)	$100–700 Median 200
11. Supervision adult and evening education	15 (4%)	$2.00 per hour 600 annually Median 250
12. Visual education	4 (1%)	$75–300 Median 150

* Only totals for the three groups and total salary ranges are given.

The following conclusions in regard to the New York State Schools surveyed seem justified on the basis of the findings of this questionnaire:

(1) Practically all schools have some type of extra pay for extra service policy but both policy and/or practice is confused or chaotic in many instances and even contradictory in a few.

(2) The program of extra pay for extra services has been carried so far in individual school systems that in some instances all duties outside of actual class meetings seem to have been contracted for on an

individual piecemeal basis! This may be accounted for partially by an administrative attempt to provide salary increases where boards were unwilling to increase basic salary schedules, although no direct evidence of this was uncovered by the study.

(3) City and village schools are much more likely to have extra pay schedules for extra services than are central schools—42 and 38% respectively as compared to 11%.

(4) Apparently central schools have gone much further toward a solution to this problem than the village and city schools, since they are much more likely to include extra pay in a basic salary—35% as compared to 10 and 17%—or if there is no salary differential they are more likely to give load compensation—20% as compared to 12 and 8%.

(5) Practically all schools—94%—indicate the source of extra pay funds was the board of education. However, only about one third of the schools replying answered this question. This figure may not, therefore, represent the actual situation in the schools of the state as a whole.

(6) Apparent inconsistency in policy and practice within some school systems is explained by a change of policy which was not made retroactive.

(7) Less than 2% of the schools replying stated that extra pay came exclusively from gate receipts and only 2.5% reported a combination of gate receipts and Board of Education Funds. One school reported use of city recreation funds for this purpose. Therefore, only 9 schools out of 165 reported deviation from the generally accepted practice of financing extra duties from Board of Education funds.

(8) The only instance where all schools reporting gave extra pay for extra service was in city superintendencies for coaching football. Basketball was a close second with 88% of the same group reporting extra pay.

Bilateral Effects of Muscle Activity

ARTHUR T. SLATER-HAMMEL*
Indiana University
Bloomington, Indiana

THE TRANSFER effects of systematic exercise of muscles in one part of the body upon muscles in another part of the body has been the concern of a number of investigations. One of the earliest of these studies appears to be that of Scripture (6) at the Yale Psychological Laboratory. In this study it was found that exercise of one hand with a dynamometer resulted in an increment of muscular performance of the other hand. In a second study, conducted in the same laboratory, Davis (4) reported that systematic exercise with dumbbells, a dynamometer, and ergograph in one part of the body markedly influenced the muscular performance in other parts of the body. It was also noted that the exercise effects were greatest in symmetrical and related parts.

Wissler and Richardson (7) reported that daily exercise of pulling on a dynamometer with one arm increased muscular performance in the accessory muscle of that arm (muscles presumably not directly used in performance of the exercise) and in the muscles of the unexercised arm. In this experiment, an attempt was made to study the mechanism of these exercise effects by using tambours to record the presence of muscular contraction. From the data obtained it was concluded that contraction of one muscle in the arm resulted in a diffusion of motor impulses which produced contractions in the associated accessory muscles, and this, presumably, accounted for the improvement of muscular performance. Since the exercise effects also appeared in muscles of the unexercised arm, it was inferred that the diffusion of motor impulses spread from the exercised to the unexercised arm. In accounting for the exercise effects in the unexercised member the authors concluded: "... it must not be claimed that muscles do not receive cross-exercise until more refined methods of observation are used than heretofore available in such experiments"[1] (7, p. 37).

A series of recent investigations by Davis (1–3) have given considerable support to the theory that the transfer effects of systematic exercise are due to "cross-exercise." These studies indicate that simple voluntary movement in one limb is accompanied by muscular activity in all four limbs, i.e., in an extension of the right foot, with subject reclining, there is not

* The writer is indebted to Mr. Robert L. Stumpner, who assisted in testing and training many of the subjects.

[1] C. Wissler and W. W. Richardson, "Diffusion of the Motor Impulse," *Psychological Review*, **7**: 37, 1900.

only the normal muscle activity in the extensor muscles of that member, but there is also muscle activity in the extensor muscles of the left foot and the two hands. While this remote activity is much less than that of the active member, it is, nevertheless, substantial. In view of the general results obtained in transfer studies, it would seem that this remote activity is great enough to constitute a form of muscular exercise.

One of the most recent and comprehensive studies on the transfer effects of exercise appears to be that of Hillebrandt, Parrish, and Houtz (5). This study involved training with heavy weights, a modified Mosso finger ergograph, and a grip dynamometer. The results obtained were in general agreement with previous reports. From observations of their subjects in action, the experimenters concluded that the transfer effects of exercise were probably due to the diffusion of motor impulses and to tonic postural reflexes.

While the cumulative weight of evidence leaves little doubt but that the transfer effects are genuine, there appear to be a number of disturbing features relative to the experimental procedures of most, if not all, of the reported studies. Among the most common criticisms which can be made are the following:

1. In some instances, conclusions are based on evidence obtained from only one or two subjects.
2. The subjects and authors often appear to be the same persons.
3. From a description of the training procedures used, it would seem that the so-called unexercised members were often actively engaged in supporting the other functions.
4. None of the experiments have used control subjects, and it is impossible to estimate how much of the transfer effect was due to the experimental variable and how much to factors external to the experiment.

In view of these shortcomings, it was deemed worthwhile to further explore the transfer effects of systematic exercise. The experiment herein reported presents data relative to the bilateral effects of a systematic exercise program involving simple flexion and extension of the right forearm. While the general procedures make no claim for originality, the experiment was conducted under the following conditions:

1. No subject had any insight into the hypothesis being tested; consequently, the data obtained were probably not influenced by any psychological factors arising out of preconceptions of what the results should be.
2. During exercise the body was always placed in such a position that the unexercised member was not called upon to give support, maintain stability, etc.
3. A control group was utilized as a means of estimating the changes observed in the experimental group.

Apparatus and Procedures

The general arrangement of the apparatus and the disposition of the subject is shown in Figure 1. As can be seen from this photograph, the apparatus consisted of three exercise stalls set up along a long, sturdy table. A padded arm rest was mounted in each stall. This served to fix the upper arm and enabled an isolated muscle group (flexors of the forearm) to work against resistance until exhaustion. A length of leaded iron pipe, 1½ inches in diameter, and weighting 14 pounds, served as the resistance.

A 2 inch x 1½ inch wooden bar was mounted across each stall. The adjustment between the bar and the arm rest was such that when the sub-

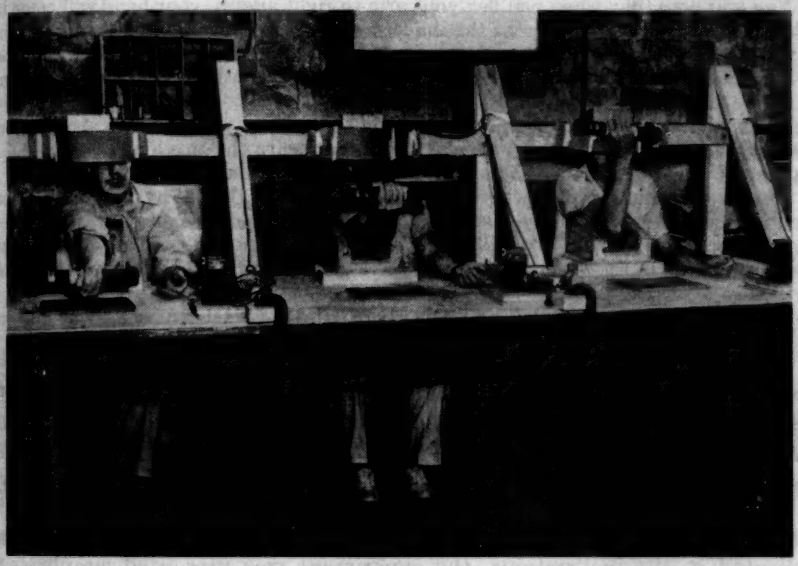

FIG. 1. Arrangement of apparatus and disposition of subjects

ject flexed his forearm to 90 degrees his hand came in contact with the bar. The outer surface of the bar (surface nearest subject) was well padded with foam rubber and served as a head rest. A padded metal plate was mounted on the inner surface of the bar. Contact of the plate with the hand closed a micro-switch and activated an electric counter, which automatically counted the arm flexions.

A metronome, wired into a buzzer circuit, served to set the rate at which arm flexion and extension was made. The metronome was adjusted to sound the buzzer at the rate of 70 per minute. This rate gave a total of 35 arm flexions per minute.

Standardized instructions were read to the subjects throughout the initial trials. During this reading the experimenter sat at one of the exercise stalls and gave a demonstration of postural adjustment, type of movement desired, etc. The text of the instructions, which explains the

subject's postural adjustments, general testing procedures, etc., was as follows:

This is a test of muscular endurance. Your task will be to flex and extend your arm while holding this weight in the palm of your hand. Your flexion and extension will be done to the rhythmical sounding of a buzzer.

At the start of the test, you will seat yourself in the chair before the exercise table as I am now seated. You will place your arm in the padded arm rest, and you will grasp the weight with the arm extended and the palm up. The side of your chest rests against the front of the padded arm rest. Your forehead rests against the padded cross bar, and your feet will be placed flat on the floor in front of the chair. Your other arm will rest comfortably on the table with the palm up. At no time should you attempt to use this arm during the test.

You will note that when you flex your arm to right angles, your hand will come in contact with the padding across the inner surface of the cross bar. Coming in contact with the bar activates a counter and automatically counts your arm movements. It is not necessary to bang the bar with any great force; a light contact is sufficient to activate the counter.

When you have seated yourself and made the correct adjustments, I will start the buzzer. After you have had several minutes to learn the rhythm, I will give the signal and you will start flexing and extending your arm as long as you can.

When you reach the point where you fail to keep up with the rhythm for two consecutive movements, you have reached the limits of your performance for the purpose of this test. At this point, you will place your hand on the table and sit quietly until I tell you to stand up. When all subjects have gone their limit, I will give the signal for you to leave the table.

REMEMBER THIS IS A TEST OF MUSCULAR ENDURANCE! The success of this test depends upon your cooperation. Do you have any questions?

Upon completion of this explanation and demonstration, the subjects were seated in the chairs before the exercise stalls. After checking for and correcting any postural faults, the buzzer was sounded to demonstrate the nature and the rhythm of the stimulus to which they would react.

It is to be noted that at no time during the experiment were the subjects introduced to the precise nature of the hypothesis under investigation; as indicated in the instructions, the experiment was presented simply as a series of muscular endurance tests.

A group of undergraduate university men were given an initial test on left arm performance. On the basis of this test, it was possible to select ten pairs of subjects with approximately equal scores. In forming the experimental and control groups, one man of each matched pair was assigned to each group by the toss of a coin. The general experimental procedures were as follows:

1. Both groups were given an initial test on left arm performance.
2. Following the initial test, the experimental group received three weeks of systematic exercise in flexion and extension of the right arm. During this training period, the subjects took what they considered to be a good workout at their own rhythm on Monday, Wednesday, and Friday. On Tuesday and Thursday the subjects went all out under regular testing conditions.

3. At the end of the training period, both groups were retested on their left arm performance.
4. Two weeks after the training period, both groups were again tested on their left arm performance.

RESULTS

Table 1 presents the experimental data on the bilateral effects of muscular exercise. A comparison of the means and standard deviations of the

TABLE 1

Data on bilateral effects of exercise

GROUP	PRE-EXERCISE LEFT ARM		END EXERCISE LEFT ARM		POST-EXERCISE LEFT ARM	
	Mean	σ M	Mean	σ M	Mean	σ M
Experimental	53.5	3.820	79.8	3.646	62.1	4.630
Control	53.2	3.946	58.2	5.896	58.4	5.033

TABLE 2

Summarizing changes in left arm performance as a result of exercising right arm

GROUP	MEAN GAIN LEFT ARM AT END OF EXERCISE	MEAN GAIN LEFT ARM POST-EXERCISE
Experimental	26.3	8.6
Control	5.0	5.2
Difference	21.3	3.4
σ Difference	5.153	5.391
t	4.134	0.631
df	9	9
P	below 0.01	above 0.5

initial left arm performance (Pre-Exercise, Left Arm) reflects the extent to which it was possible to match individuals in each pair. Actually, the difference in initial left arm performance between the individuals in each pair was never greater than 5 per cent of the range of scores, and these were effectively balanced between the two groups.

Table 2 summarizes the mean gain at the end of the exercise period and the post-exercise period for both groups. The mean difference between groups was determined from the distribution of differences between pairs. At the end of the exercise period the experimental group showed a mean gain of 21.3 flexions over the control group. That this difference is significant is revealed by a t value of 4.134. For 9 degrees of freedom, a t value of 3.250 is significant at the 1 per cent level of confidence. Any hypothesis that this difference could be attributed to chance is thus rejected.

In the post-exercise tests the experimental group showed a mean gain of 3.4 flexions over the control group. This difference is not statistically

significant and could well be attributed to chance factors. It is, however, of significance to note the rapidity with which the experimental group loses its superiority during the post-exercise period.

DISCUSSION

The evidence obtained shows that a systematic exercise program involving the flexion and extension of one arm results in a positive and significant improvement in the muscular performance of the other arm. While these results are in general agreement with earlier studies, they must be interpreted with some caution. It is, of course, possible that the bilateral effects were due simply to a raising of the subjects' tolerance to fatigue sensation. During strenuous and systematic exercise of one group of muscles a person probably learns to ignore or tolerate the feelings of muscular fatigue for a greater period of time, and this may transfer and influence the performance of other muscle groups. Also it is possible that the training effect is due to a bilateral transfer of motor coordination. On the other hand, the fact that bilateral gains are rapidly lost after the cessation of exercise suggests the gains are due primarily to exercise.

This suggestion is further supported by the Davis studies (1–3), which show that simple voluntary movement of one extremity results in muscular excitations in all four extremities. These facts of remote muscular excitation provide a possible mechanism through which the bilateral effects of muscle activity can occur. The results of the present study indicate that remote muscular excitation can be utilized to improve the muscular performance of remote musculatures.

The investigations by Davis, along with the several studies supporting one of the theoretical implications in Davis' findings, imply a conception of muscular activity quite unlike that of general kinesiology. As stated by Davis[2] (2):

> Even in a very simple sort of response there is a widespread "structural" pattern of action. The true unit of activity must be, not the flexing or extending of a particular muscle or limb, but an adjustmental design in which many regions of the organism participate.

It is suggested that further insight into the nature, extent, patterns, and conditions of remote muscular excitation will lead to a better understanding of physical education activities and corrective procedures. That the transfer effects of exercise may be used as a therapeutic tool has been suggested by Hillebrandt, Parrish, and Houtz (5).

SUMMARY

Twenty male college students were employed in a study to test the bilateral effects of systematic exercise. Ten students received three weeks of exercise in flexion and extension of the right arm. Ten control students re-

[2] R. C. Davis, "The Pattern of Muscular Action in Simple Voluntary Movement," *Journal of Experimental Psychology*, 31: 363, 1942.

ceived no special exercise. At the end of the exercise period, the experimental group showed a significant gain over the control group in flexion and extension of the left arm. Two weeks after the exercise period the experimental group lost their superiority over the control group in their left arm performance. It is suggested that exercise of one arm produces a positive and significant improvement in the muscular performance of the other arm.

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A Frictional Bicycle Ergometer

PETER V. KARPOVICH, M.D.
Springfield College,
Springfield, Mass.

THE FRICTIONAL type of bicycle ergometer, in which resistance to pedaling is supplied by friction against the wheel of the bicycle, was the only type used in physiology until the second decade of this century. The ones of that day had various constructional and operational drawbacks, however, which made their use rather difficult. Therefore, two other types, the electrodynamic and the electromagnetic, were developed. In the electrodynamic type (5, 8), an electric dynamo geared to the bicycle supplies the needed resistance. In the electromagnetic type (3), the back wheel of the bicycle is replaced by a copper disk revolving between the poles of an electromagnet, which acts as a brake.

Unfortunately, these two types of ergometers are expensive, require expert installation, calibration, and handling.

In one investigation (4), the present writer decided to use nine bicycle ergometers. The cost of electrodynamic or electromagnetic bicycles would have been prohibitive; moreover the installation and calibration would have required expert attention. For this reason, it was decided to use the frictional type described by Martin in 1914 (7). Martin called it a "simple and convenient form", but in the writer's experience, it proved to be neither. The adjustment of the two spring scales on each bicycle required four hands and a "blitz" mental calculation, and the thin fabric from which the brake bands were made did not last long. Mechanical engineers were consulted about the frictional bicycle ergometer described by Lamb (6). In their opinion, it had constructional weaknesses because the flywheel had to be weighted with a lead piping around the rim, complicating the balancing of the wheel. A model described by Amar (1) was also judged to be impractical.

After trying out a number of variations in the construction of the ergometer, the present modification was designed. During the first experiment which lasted over four months and involved the use of the bicycles for several hours daily, the bicycles were kept in working order by a high-school student. These ergometers are now 10 years old. They have been ridden for over 4000 miles; moreover, they have been used by students in laboratory work where they are often abused. Yet they are still in working shape and, with the exception of replacing worn out pedals and other small parts, they have required little attention.

For schools of physical education, this improved frictional ergometer

may be of great practical importance. Most of these schools have very small budgets, if any, for laboratory work in physiology of exercise. Often, space is also limited. Yet, for efficient teaching, a laboratory may require several bicycle ergometers. They should be inexpensive, simple to construct, install, maintain, and operate. They also should be able to withstand hard usage by students, and preferably be portable.

The simplicity of operation of the frictional bicycle ergometer explains why it has been used by other investigators. For instance, Asmussen and Bøje (2) used this type although there was an electromagnetic one available.

During the past three years, the writer has received a sufficient number of inquiries regarding the frictional bicycle ergometer to warrant the writing of the present article.

Construction of the Ergometer. An ordinary bicycle can be easily converted into this ergometer, although the reconversion of a commercial stationary bicycle gives a more compact machine. The ergometer described here, and shown in Figure 1, represents such a reconverted "Rollfast" exercise bicycle. The original solid rubber tire on the front wheel has been replaced by a one and one-half inch wide, and three-quarters of an inch thick steel band welded to the rim and made true on a lathe. The total weight of the wheel is about 20 lbs.; thus this wheel has acquired also the function of a flywheel. Because of the momentum developed by this wheel, the operation of the bicycle becomes smooth. Without the flywheel, the movements of the legs would be jerky, and fatiguing, and the speed would fluctuate considerably. A length of automobile brake band (*D*) has been placed around the flywheel. The upper end of the brake band is connected with a spring scale (*A*) by means of a cord, and the lower end of the brake is connected with suspended weights (*B*) and (*C*). The cords are guided by the three ball-bearing pulleys (*F*). (The number of pulleys may be reduced to two.) The bicycle is bolted to the platform, to which is attached a frame (*G*) supporting the scale and the weights. The sizes of the platform and the frame are arbitrary. Rather convenient dimensions are: length of the platform, 5 feet; width of the platform and the frame, 20 inches; distance of the upper cross piece of the frame from the floor, 5 feet; distance of the lower cross piece from the floor, 3 feet. These dimensions are arbitrary. Anyone can re-design this construction to fit his own conditions.

When a need arose for an ergometer to be used in a low pressure chamber, the writer designed a very compact, portable ergometer that could fit the space available.

The bicycle has a speedometer (*E*) showing the speed in miles per hour and the distance covered by the flywheel. It can be reset to zero before a ride. (An old automobile speedometer of resetting type may be used.) If the radius of the flywheel differs from that of the ordinary bicycle for which the speedometer has been manufactured, a correction table can be made easily by measuring the distance traveled by any point on the flywheel corresponding to one mile on the speedometer. A tally counter, recording

either the number of wheel revolutions or pedal revolutions (or both) can be installed. The rate of pedal revolutions may also be conveniently controlled by a metronome.

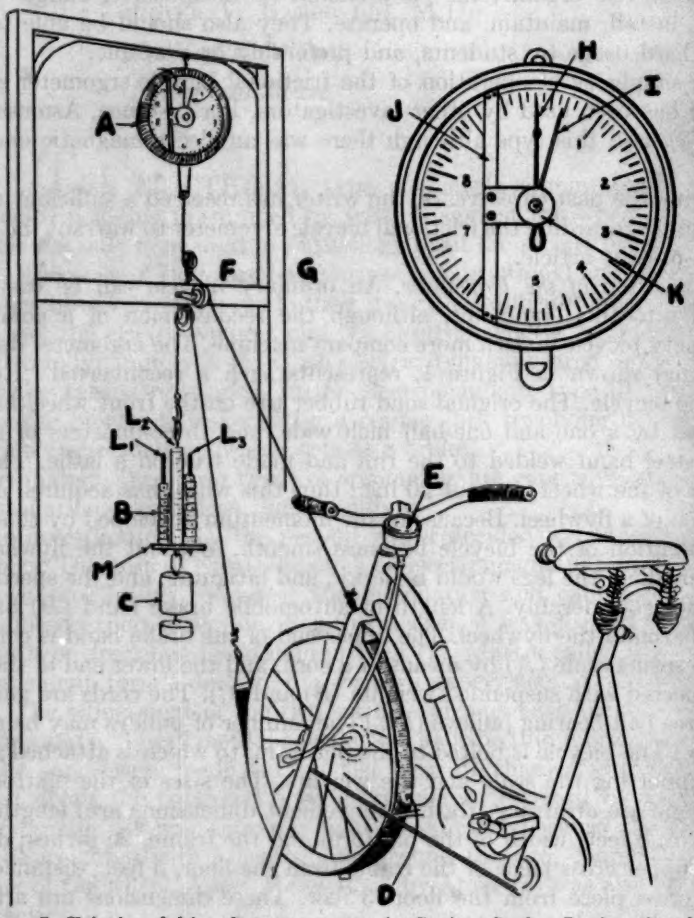

FIGURE I. Frictional bicycle ergometer. *A*—Spring Scale, *B*—fractional weight holder, *C*—weights, *D*—brake, *E*—speedometer, *F*—pulleys, *G*—frame, L_1, L_2, L_3 supporting rods, *M*—Crossbar holding vertical rods together.

Inset. Spring scale, *H*—Indicator, *I*—marker, *J*—bar, *K*—wheel for moving, *I*

The Spring Scale. (Figure 1 inset) The spring scale is an ordinary commercial scale graduated in one ounce divisions up to 10 lbs., but capable of withstanding a much larger load. This sturdy scale is preferred to a lighter one, say a two-pound scale described by Lamb (6), because it increases the ergometer's durability. Most of the weights used are heavier than five lbs. Occasionally a 20-pound weight may be used. When a bicycle is stopped

suddenly, a heavy weight may completely ruin a light spring scale. In order to note possible changes in the position of the pointer, a special marker (*I*) is attached to the scale. The marker can be set at any position by turning the wheel (*K*) supported by a bar (*J*).

The Fractional Weight Holder. (Figure 1) The holder consists of three rods, L_1, L_2, and L_3 held together by a horizontal bar. The purpose of the outer rods is to hold the one ounce fractional weights. To the middle rod is attached a rule divided into sections equal to the height of a single weight. Each section is numbered from one to 16 upward so that the number of weights can be told at a glance. The hexagonal nuts, made to weigh one ounce each by drilling a hole in the side, have been found to be expedient as fractional weights. The holder is suspended from the cord attached to the lower end of the brake belt. The middle rod has a loop from which the main weights are suspended. The spring scale is so adjusted that when the empty fractional weight holder is attached to it, the reading will be zero.

Principle of Operation. Work load in this type of ergometer is provided by the resistance caused by the friction between the flywheel and the brake band. The amount of friction is controlled by the weights, (*B*) and (*C*), shown in the illustration. When the bicycle chain is removed from the flywheel, the reading on the spring scale is equal to the suspended weight. When the subject pedals the bicycle, the friction of the wheel against the brake band lifts and partially supports the suspended weight. The reading on the scale therefore is reduced by an amount equal to this friction. Thus the friction or work load is equal to the weight suspended minus the scale reading.

Suppose it is desired to have five lbs. of work load. To obtain this, make (*C*) equal to four and one-half lbs. and place eight one-ounce weights on (*B*) so that the sum of (*C*) and (*B*) will equal five lbs. Let someone ride the bicycle and observe the reading on the scale. Suppose that the scale is eight ounces. This means that the friction is 5 lbs. − 8 ounces = 4 lbs. 8 ounces. Since it was desired to have friction equal to five lbs., it is necessary to place on the weight holder eight ounces more and the friction then will become: 5 lbs. 8 ounces − 8 ounces = 5 lbs., The marker (*I*) should then be moved so that it will be over the pointer (*H*) and the experiment may be started.

(weight) (scale reading) (friction)

(weight) (scale reading) (friction)

Suppose that during the experiment, the pointer (*H*) on the spring scale moves three one-ounce divisions clockwise. Thus, the scale reading becomes three ounces greater, which means that the friction for some reason has decreased by three ounces. To bring the friction back to the original value, three ounces must be added to the fractional weight holder and the marker (*I*) reset over the new position of the pointer (*H*). If the pointer moves counterclockwise and the scale reading becomes less than before, it means that the friction has increased by the corresponding number of

ounces. To bring back to the original, an equal weight must be removed from the fractional weight holder and the marker reset.

A simple rule may help in making adjustments: *If the pointer moves DOWN, put DOWN additional weight. If the pointer moves UP, lift UP weight from the fractional weight holder.* By keeping the flywheel well polished and the brake band clean, "spontaneous" fluctuations in scale readings may be entirely eliminated. In passing, it should be stated that under usual laboratory conditions friction is not affected by the speed of the flywheel.

Sweat Guard. During prolonged experiments riders may sweat profusely. Drops of sweat falling on the flywheel will play havoc with friction. To prevent this, it is strongly recommended that a sweat guard be placed above the flywheel. Transparent plastic material will be found convenient for this purpose, because it does not hinder observing the brake band and the flywheel.

Calculations of Work Done on the Bicycle Ergometer. The general formula for work is F × D, where F is force used and D, the distance covered. In the case of the bicycle, the force obviously is equal to the resistance to be overcome; therefore, F is equal to the weight suspended minus the scale reading. The distance D is equal to the distance traveled by the flywheel. This can be found if the circumference of the flywheel, $2\pi r$ is multiplied by the number of its revolutions during a given period, n, or $2\pi r \times n$. Work done on the ergometer in a given time, therefore, is equal to $F \cdot 2\pi r \cdot n$ or (friction) × (wheel circumference) × (number of wheel revolutions during that time).

Sometimes exercise on the bicycle is designed so that the rider has to perform a specified number of pedal revolutions per minute. Suppose that the amount of work desired is 4,350 ft.-lbs. per minute, and the number of pedal revolutions is to be 60 per minute. To calculate the required friction, it is necessary to find out the number of feet traveled by the flywheel for each pedal revolution. Suppose that one pedal revolution corresponds to 14.5 feet of distance covered by the flywheel. Then the distance covered in 60 pedal revolutions per minute will be 14.5 ft. × 60 = 870 ft. Since the total amount of work desired per minute is 4,350 ft. lbs., the friction must be 4,350 ft. lbs ÷ 870 = 5 lbs.

Suggestions for Type and Number of Weights. It has been found expedient to have the following weights for each bicycle: one each of one-half, one, two, four, and ten lbs. These weights may be cast of lead, and should have a hook on the top and an eyelet at the bottom. They should be plainly marked as to their weights. In addition, 32 one-ounce weights are required for the fine adjustments.

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A Questionnaire Study Concerning the Development of Co-Education in College Physical Education

ROBERT T. KRETCHMAR, ED.D.

Department of Physical Education,
Ohio State University

WITHIN the past two decades a host of factors have given impetus to the development of co-education in college physical education. Studies made by Dalrymple,[1] Cobb,[2] and Bookwalter[3] have pointed out the significant progress which was made in this area during the 1930's. The entry of this country into World War II served as a temporary check to these developments. The paucity of civilian male students upon college campuses during the war years, along with the great emphasis placed upon physical development in college programs, combined to halt temporarily further developments in co-education. With the return of peace in 1945, it seemed quite natural to expect a resumption of these developments which had begun during the decade preceding the war.

The present study which was made in the spring of 1947 sought to determine: 1) present practices in co-education in college physical education, 2) opinions of persons prominent in college physical education concerning co-educational developments.

The gathering of this data was made possible only through the cooperation of the men and women college physical educators who participated in the questionnaire study. Appreciation is here expressed to these people and to Miss Helen Hazelton, Purdue University, and Dr. Harry Scott, Teachers College, Columbia University, for their assistance in selecting the participants for the study and their advice in respect to the content of the questionnaire.

Method

The questionnaire method was employed to secure the data for this study. A group of 118 men and women engaged in college physical edu-

[1] Gerald R. Dalrymple, *A Survey of Co-Educational Physical Education in Leading American Universities and Colleges.* M.S. Thesis (Unpublished), Louisiana State University, 1937.

[2] Louise S. Cobb, "The Co-educational Physical Education Class at the College Level," *Research Quarterly*, 10: 20-32, December, 1939.

[3] Karl W. Bookwalter, "The Co-educational and Co-recreational Use of Physical Education Activities," *Proceedings of College Physical Education Association*, p. 62-68, December, 1940.

cation were selected to participate in the study. In the selection of these men and women consideration was given to their present positions, their professional experience, and the geographical location of the colleges and universities at which they were serving. Since the questionnaire sought not only *opinions* but also factual information regarding the *present practices* in co-education in college physical education, a wide geographical representation was desired. Consideration was given to the geographical districts designated by the American Association for Health, Physical Education, and Recreation.

The selection of the women to whom questionnaires were sent was made with the assistance of Miss Helen Hazelton of Purdue University, formerly president of the National Association for Physical Education for College Women. A group of sixty-three women was selected to participate in the study. The selection of the men to whom questionnaires were sent was made with the assistance of Dr. Harry A. Scott of Teachers College, Columbia University, formerly president of the College Physical Education Association. A group of fifty-five men was selected. The study was endorsed by both the College Physical Education Association and the National Association of Physical Education for College Women.

TABLE 1

An analysis of questionnaire distribution and return

DISTRICT	MEN			WOMEN			COMPOSITE		
	Sent	Returned	Per cent of return	Sent	Returned	Per cent of return	Sent	Returned	Per cent of return
Eastern	14	13	92.85	13	12	91.54	27	25	92.59
Midwest	14	14	100.	17	16	94.12	31	30	96.77
Central	8	7	87.50	10	8	80.	18	15	83.33
Southern	8	7	87.50	9	9	100.	17	16	94.12
Northwest	6	4	66.67	6	6	100.	12	10	83.33
Southwest	5	5	100.	8	7	87.50	13	12	91.54
Totals	55	50	90.90	63	58	92.06	118	108	91.52

Table 1 includes a compilation of the distribution and return of the questionnaires. The response was particularly gratifying. Of the 118 questionnaires distributed, 108 were returned—a percentage of 91.6. A total of seventy-nine colleges and universities were represented by the 108 returns. The percentage of return from questionnaires distributed to male physical educators was 90.0. Two of the men to whom questionnaires were sent referred them for reply to members of the women's physical education departments in their respective colleges. Apparently in these two institutions co-education in physical education is administered largely by the women's department. The percentage of return from questionnaires distributed to women physical educators was 92.1. The comparably high percentage of return from both men and women engaged in college physical

eduation would indicate considerable mutual concern with co-education, and should tend to dispel the belief that male physical educators are indifferent to developments in this area.

Part I

OPINIONS

Providing for Co-Education. Table 2 indicates the opinions of the prominent physical educators concerning the desirability of providing for co-education in some phase of the college physical education program. A five point rating scale ranging from definitely desirable to definitely undesirable was employed. An overwhelming majority of the group indicated that it is definitely desirable to provide for co-education in some phase of the program. Only slightly more than one per cent of the group were uncertain

TABLE 2

Opinions concerning the desirability of providing for co-education in some phase of the college physical education program

RATING	MEN		WOMEN		COMPOSITE	
	No.	Per cent	No.	Per cent	No.	Per cent
Definitely desirable	40	83.3	50	83.3	90	83.3
Probably desirable	5	10.4	10	16.7	15	13.9
Uncertain	1	2.1	—	—	1	0.9
Probably undesirable	1	2.1	—	—	1	0.9
Definitely undesirable	1	2.1	—	—	1	0.9
Totals	48		60		108	

or considered it undesirable to make provisions for mixed participation in physical education. There was no significant difference between the opinions of the men and women participating in the study.

Phase of Program in Which Provision Should Be Made for Co-Education. Table 3 indicates the opinions of the participants in the study concerning the phases of the physical education program in which provision should be made for co-education. Approximately 77 per cent of the group believed it very desirable to provide for co-education in the organized voluntary program (no credit given). Sixty of the group, or 55.6 per cent, of those responding indicated that it would be very desirable to include some provision for co-education as an elective within the prescribed program (credit given). A surprisingly large percentage, 21.3, believe that some co-education in physical education should be provided in the program required of all students. Only 4.7 per cent of the group considered it very undesirable to provide for co-education in this phase of the program. The findings make it clear that many of the group believe that provision should be made in several different phases of the physical education program for co-education.

Forces Fostering Development. In an attempt to find out the relative im-

portance of some of the forces which have stimulated and fostered the development of co-education in college physical education, the opinions of a number of men and women prominent in college physical education were sought. Table 4 contains the findings. The group was asked to rate each of the listed factors on a five-point scale ranging from very significant to very insignificant.

According to the ratings of the group it would appear that the most significant factor in fostering the development of co-education in college

TABLE 3

Opinions concerning the desirability of co-education in the various phases of the college physical education program

PHASE OF PROGRAM	VERY DESIRABLE		DESIRABLE		ACCEPTABLE		UNACCEPTABLE		VERY UNACCEPTABLE		NO OPINION	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
As a phase of the *organized* voluntary recreational program sponsored by the department of physical education. (Instruction given where desired; no credit given)	83	76.9	16	14.8	5	4.7	1	0.9	—	—	3	2.8
As a phase of the unorganized spontaneous recreational program (facilities made available by the physical education department but no organized program sponsored. (No credit given)	77	71.3	12	11.1	7	6.5	3	2.8	2	1.9	7	6.5
As an elective within the prescribed program. (Credit given)	60	55.6	19	17.6	18	16.7	2	1.9	1	0.9	8	7.5
As an integral part of the prescribed program. (Required of all. Credit given)	23	21.3	17	15.7	23	21.3	22	20.4	5	4.7	18	16.7

physical education is the increased emphasis which has been placed in education upon preparation for the worthy use of leisure time. Also considered as very significant factors were student interest in co-education and the increased emphasis in college physical education programs upon recreational activities such as golf, tennis and bowling. Of the factors listed the group considered the increased social freedom of women as the least significant factor. It must be noted, however, that 28.7 per cent of the group considered this a very significant factor. Because of the comparatively high percentage of very significant ratings given to each of the factors listed in Table 2, it must be concluded that the group considered all of them as significant factors, some more than others—in fostering the development of co-education in college physical education.

Forces Hindering Development. Listed in Table 5 is a tabulation of the opinions of the college physical educators concerning the relative significance of the factors and forces which have hindered the development of co-education in college physical education. Again the group was asked to rate each of the listed factors on a five-point scale ranging from very signifi-

TABLE 4

Ratings of various factors in respect to their significance in fostering the development of co-education in college physical education

FACTOR	VERY SIGNIFICANT		SIGNIFICANT		PROBABLY SIGNIFICANT		INSIGNIFICANT		VERY INSIGNIFICANT		NO OPINION	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
The increased emphasis in education upon preparation for worthy use of leisure time	68	51.1	28	25.9	8	7.4	1	.9	1	.9	4	3.7
The increased emphasis in college physical education programs upon recreational activities of a dual or individual nature, such as golf, tennis, etc.	61	56.5	32	29.6	13	12	—	—	—	—	2	1.9
Student interest. The natural interest of college men and women in associating with one another in informal social activities	60	55.5	30	27.7	11	10.2	4	3.7	1	.9	2	1.9
The increased emphasis in college curricula upon *functional* education. (The teaching of these skills which are actually utilized in living)	56	51.9	27	25	12	11.1	7	6.5	1	.9	5	4.6
Increased emphasis in physical education upon social as well as physical development	54	50	40	37	7	6.5	5	4.6	—	—	2	1.9
The evolving position of women in society. (Increased participation of women in the social, economic and political spheres of our culture)	31	28.7	39	36.1	17	15.7	13	12	3	2.7	5	4.6

cant to very insignificant. Of the fourteen factors listed, the group considered the limitations of facilities as the most significant factor impeding the development of co-education in the college physical education program. Given the second highest percentage of very significant ratings was the factor of opposition or indifference of male physical educators to this type of program. This is in confirmation of the knowledge that in the majority of institutions sponsoring co-education in physical education, the impetus

TABLE 5

Ratings of various factors in respect to their significance in hindering the development of co-education in college physical education

FACTOR	VERY SIGNIFICANT		SIGNIFICANT		PROBABLY SIGNIFICANT		INSIGNIFICANT		VERY INSIGNIFICANT		NO OPINION	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
Limitations of physical education facilities. (Separation of men's and women's facilities, etc.)	44	40.7	31	28.7	21	19.4	8	7.4	3	2.8	1	.9
Opposition or indifference of male physical educators toward co-education	34	31.5	31	28.7	31	28.7	7	6.5	3	1.9	3.	2.8
Tradition. (Established custom of separating men and women for physical education)	34	31.5	28	25.9	26	24.1	12	11.1	7	6.5	1	.9
Difference in athletic abilities of men and women	29	26.9	38	35.2	21	19.4	13	10.2	4	2.7	3	2.8
Lack of preparation of staff members for handling co-educational classes	27	25	34	31.5	25	23.1	15	13.9	4	3.7	3	2.8
Differences in strength and endurance of men and women	25	23.1	40	37.9	23	21.3	15	13.9	5	4.6	—	—
Administrative problems such as separation of men's and women's departments of physical education	23	21.3	29	26.9	29	26.9	18	16.6	4	3.7	5	4.7
Lack of interest of men students in such a program	6	5.6	19	17.6	45	41.7	23	21.3	11	10.2	4	3.7
Opposition or indifference of female physical educators toward co-education	5	4.6	19	17.6	34	31.5	29	26.9	14	12.9	7	6.5
The effect of World Wars I and II on Physical Education Programs. (Emphasis on physical development)	5	4.6	11	10.2	16	14.8	38	35.2	30	27.8	8	7.4
Sociological Considerations. Opposition of our form of society. (The mores of our culture frown upon men and women participating jointly in sports activities)	3	2.8	14	12.9	19	17.6	41	37.9	27	25	4	3.7
Opposition ofcollege presidents toward this program	2	1.9	9	8.3	14	12.9	20	37	18	15.6	25	23.1
Lack of interest of women students in such a program	1	0.9	12	11.1	20	18.5	44	40.7	26	24.1	3	4.7
Moral implications. (Fear of indiscreet relations resulting from such a program)	—	—	4	3.7	14	12.9	43	39.4	39	36.1	9	7.4

for this development has come from the faculty of the women's physical education staff or the members of the Women's Athletic Association. It must be pointed out, however, that the large percentage of return of this questionnaire form from both male and female physical educators would suggest that among prominent men and women physical educators there is a comparably high interest in developments in this area.

Other factors which received a high percentage of very significant ratings were tradition, differences in athletic ability between men and women, and the lack of preparation of staff members for handling co-educational classes. The latter would suggest the need for placing increased emphasis in our professional preparation programs for physical education teachers upon the methods of handling co-educational classes. Those factors which the group felt were of comparatively little significance in hindering development in this area were moral implications or fear of indiscreet relationships developing between men and women, lack of interest of women students, and the opposition of college presidents. It is interesting that the lack of interest of men students in this type program was rated as a very significant factor by a higher percentage of the group than was the lack of interest of women students. In both instances, however, the percentage of very significant ratings was small, so small, in fact, as to suggest that the lack of student interest can not be considered a significant factor impeding the development of co-education in physical education.

Probable Future Developments. The present study, as well as previous studies made by Bales[4] and Bookwalter,[5] indicates that physical educators are of the opinion that co-education is not a fad or temporary development in physical education. An overwhelming majority of the participants in the study (88.9%) believe co-education will in the future increase in significance in physical education programs. Developments and trends in social and educational areas as previously suggested indicate that there is at present a preponderance of forces favorable to the further development of co-education in physical education.

The Scope of Activities. The scope of activities suitable for co-education is surprisingly large. Bookwalter[6] suggests that there are more than ninety-five different physical recreational activities suitable for boys and girls to participate in jointly. In making such a statement, he undoubtedly includes many social recreational activities such as checkers, chess, and shuffleboard, which are not normally included in the prescribed program of physical education.

The participants of the questionnaire study were asked to indicate the suitability of nineteen different sport activities for co-education. Each

[4] Mary Bush Bales. *Utilizing College Co-recreation as a Factor in Social Interaction.* M.S. Thesis (Unpublished), Louisiana State University, 1941.

[5] Karl W. Bookwalter. "The Co-educational and Co-recreational Use of Physical Education Activities." *Proceedings of College Physical Education Association,* pp. 62–68, December, 1940.

[6] *Bookwalter.* Op. cit., p. 62–68.

sport was rated in respect to a five-point scale ranging from very suitable to very unsuitable. The activities which received the highest percentage of very suitable ratings were social dancing, folk dancing, archery, horseback riding, hiking and ice skating. The activities which received the highest percentage of unsuitable and very unsuitable ratings were handball, softball, and fencing. (See Table 6.)

There was disagreement regarding the suitability of softball for co-educational situations. Several inserted comments on the questionnaire to the effect that softball would be suitable in certain informal situations such as a picnic or an outing, but not in highly organized and competitive situa-

TABLE 6

Ratings of activities in respect to suitability for co-education

ACTIVITY	VERY SUITABLE		SUITABLE		PROBABLY SUITABLE		UNSUITABLE		VERY UNSUITABLE		NO REPLY	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
Social Dancing	105	97.2	2	1.9	—	—	—	—	1	0.9	—	—
Folk Dancing	98	90.7	7	6.5	1	0.9	1	0.9	1	0.9	0	—
Archery	92	85.1	12	11.1	3	2.8	—	—	—	—	1	0.9
Horseback Riding	88	81.5	14	13.	2	1.9	1	0.9	1	0.9	2	1.9
Hiking	86	79.6	17	15.7	1	0.9	1	0.9	0	—	3	2.8
Ice Skating	86	79.6	16	14.8	1	0.9	2	1.9	1	0.9	2	1.9
Roller Skating	79	73.1	19	17.6	2	1.9	2	1.9	1	0.9	5	4.7
Golf	78	72.2	26	24.1	3	2.8	0	—	—	—	1	0.9
Bowling	76	70.	25	23.1	4	3.7	2	1.9	—	—	1	0.9
Swimming	72	66.7	24	22.2	4	3.7	3	2.8	2	1.9	3	2.8
Badminton	71	65.7	27	25	6	5.6	2	1.9	—	—	2	1.9
Skiing	67	62.	28	25.9	6	5.6	2	1.9	1	0.9	4	3.7
Table Tennis	65	59.3	37	34.3	2	1.9	1	0.9	—	—	4	3.7
Tennis	50	46.3	44	40.7	7	6.5	4	3.7	—	—	3	2.8
Fly Casting	50	46.3	30	27.8	19	17.6	1	0.9	1	0.9	7	6.5
Volley Ball	16	14.8	39	36.1	36	33.3	13	12.9	1	0.9	3	2.8
Fencing	13	12	22	20.4	32	29.6	28	25.9	9	8.3	4	3.7
Softball	3	2.8	20	18.5	27	25	44	40.7	13	12.	1	0.9
Handball	1	0.9	1	0.9	10	9.2	50	46.3	34	31.5	12	11.1

tions. A similar opinion was expressed in an article by Wohlford.[7] There seemed to be general agreement concerning the unsuitability of handball as a co-educational activity. Approximately 78 per cent of the participants rated this activity very unsuitable or unsuitable. With the exception of handball, softball, fencing, and volleyball, all activities included in Table 6 received a high percentage of suitable and very suitable ratings.

It may appear surprising to some that the activities fencing and modern dance are included in this list. Only 32 per cent of the physical educators participating in the study rated fencing a suitable co-education activity. Co-educational modern dance was not considered sufficiently popular to merit inclusion in the original list of activities which the physical educators

[7] Mildred Wohlford. "Co-recreational Softball." *Journal of Health and Physical Education*, **15**: 337, 1944.

evaluated. Perhaps both of these activities have been under-rated in respect to their suitability for co-education. Physical educators who have had experience with co-educational groups in either fencing or modern dance are enthusiastic concerning the suitability of these activities.

In addition to the list of activities included in the questionnaire the following were suggested by the participants as suitable for co-education: sailing, canoeing, riflery, tumbling, camping, field hockey, horseshoes, modern dance, croquet, cycling, and camping.

Selection of Instructors. It is generally agreed among college physical educators that either a man or woman instructor can satisfactorily handle a co-educational class provided he has the proper professional and personal qualifications.[8] Those who oppose either a male or female instructor alone handling such a class give reasons such as the following: (a) students of opposite sex do not respect the instructor; (b) unwholesome physical contacts are necessary; (c) the mental attitude of the class may hinder learning; (d) the instructor's knowledge of the opposite sex may be limited, and (e) the instructor may lack preparation to handle such a group. Apparently many believe that a properly qualified instructor of either sex can rise above these objections. This was the opinion of 76.4 per cent of the participants in the questionnaire study.

Part II

PRESENT PRACTICES

Present Provision for Co-Education in the Program. In contrast to the opinions of the participants concerning provision for co-education in physical education, it is interesting to note some of the present practices in this area. The study revealed that at 93.7 per cent of the colleges represented, provision is currently made in some phase of the physical education program for co-education. In 73.4 per cent of the schools, provision for co-education is made in the voluntary recreation program; however, at 46.8 per cent of the schools co-education is available as an elective within the required physical education program. In the original questionnaire an attempt was made to determine also whether any colleges required all students in the prescribed physical education program to participate in some co-educational activity. In responding to this question many apparently made no distinction between the required program for the general college student and the prescribed program for the professional student in physical education. Because of this, these findings will not be included. In her study in 1939 Cobb[9] found that no college which was surveyed required students in the prescribed program to participate in some co-educational activity. It is uncertain whether the situation in 1949 is the same. It is known, however, as indicated in Table 3, that a total of 23 college physical educators

[8] Mable Lee. *The Conduct of Physical Education.* New York: A. S. Barnes & Company, 1937.

[9] Louise S. Cobb. "The Co-educational Physical Education Class at the College Level," *Research Quarterly*, **10**: 30-32, December, 1939.

believe it very desirable to require some co-educational physical education of the students in the prescribed program.

Unique Developments. The questionnaire study revealed that in fifty of the seventy-nine colleges represented in the study co-educational clubs have been organized in various sport activities. At one university co-educational sports clubs in 12 different sports activities have been formed. Several colleges have as many as 9 co-educational sports clubs. The most popular activities for club organization are skiing, square dancing, badminton, swimming, hiking, modern dancing and fencing. The popularity of hiking and badminton clubs is rather commonly known. Daniels[10] in 1940 reported the existence of upwards of 75 collegiate hiking clubs. The current study revealed that hiking and badminton clubs exist in 25 per cent of the colleges surveyed. Sixty-five of the colleges indicated that they are providing for special co-educational sports events such as "Sports Nites," "Play Days," "Folk Dance Frolics," and "Mixed Swims."

Although not shown in the questionnaire study, it was revealed in a series of interviews that co-education is now finding expression in the voluntary recreation programs of many colleges whose student body is restricted to one sex. For example, West Point now encourages co-recreational sports activities on weekends. Such equipment as golf clubs, tennis racquets, and skiis are made available on weekends for the use of the cadets and their guests. Horseback riding and swimming are also popular. At Connecticut Wesleyan the Student Christian Association has made provision to have girls from such schools as Wellesley, Smith, Vassar, and Connecticut College visit the campus on weekends. On several of these occasions the department of physical education has organized co-educational swimming and hiking parties. Smith College students enjoy hiking and skiing parties with students from Amherst. Women of Mount Holyoke College have participated with Amherst men in golf and riflery. Members of the outing club of Skidmore College have arranged various outing events with students from Union, Dartmouth, and Rensselaer. Although the departments of physical education in these schools are encouraging these activities, the students are initiating, planning and organizing the programs.

The Segregation of Gymnasium, Swimming Pool and Tennis Court Facilities for Men and Women. As evidenced by the study made in 1937 by Dalrymple[11] and the questionnaire study reported herein, the majority of colleges and universities in this country provide separate gymnasia for men and women. Dalrymple in his survey found that thirty-four of fifty-two, or 65.4 per cent of the schools studied, provided segregated gymnasium facilities. In the present study, it was found that fifty-two of seventy-nine

[10] Arthur S. Daniels. "College and University Outing Clubs," *Journal of Health and Physical Education*, **9**: 278–81, May, 1938.

[11] Gerald Richard Dalrymple. *A Survey of Co-Educational Physical Education in Leading American Universities and Colleges.* M.S. Thesis (Unpublished) Louisiana State University, 1937.

or 64.6 per cent of the schools surveyed, provided separate gymnasium facilities. It was revealed also that swimming pools and tennis courts are more commonly shared by college men and women than are gymnasium facilities. At forty of the schools (50.6 per cent) the swimming pool is used by both men and women; and at sixty-four (81 per cent) the tennis courts are shared.

In the questionnaire study those physical educators whose schools maintained separate gymnasia were asked whether provision was made in the men's or women's gymnasium for dressing and shower facilities for the opposite sex. Of fifty-one schools maintaining separate facilities, twenty-eight or 54.9 per cent answered in the affirmative. Many of this group inserted comments to the effect that the provisions made in this respect were at best makeshift and inadequate.

SUMMARY OF FINDINGS

1. The most significant factors fostering the development of co-education in physical education are: 1) the increased emphasis in education upon preparation for worthy use of leisure time, 2) the increased emphasis in physical education programs upon recreational activities, 3) the natural interest of college men and women in associating with one another in social activities, and 4) the increased emphasis in physical education upon social development.

2. The most significant factors hindering development in this area are: 1) the limitations of present facilities, 2) the indifference of male physical educators, 3) the tradition of separating men and women for physical education, 4) the difference in athletic ability of men and women, 5) the lack of preparation of staff members to handle co-education classes, and 6) the differences in strength and endurance of men and women.

3. It is definitely desirable to provide for co-education in some phase of the college physical education program.

4. Co-education is desirable in both the voluntary and prescribed phases of the program. It was the opinion of the questionnaire participants that the voluntary, non-credit phase of the program is the most desirable place for co-educational activities.

5. Either a male or female instructor may handle a co-educational class, providing he is professionally qualified, socially well adjusted, and in sympathy with this type of program. Obviously, a person who is openly skeptical of the merits of co-education would be unsuitable as an instructor for such a class.

6. There is a wide range of sport activities which are suitable for co-educational participation. Geographical location and facility limitations serve to preclude many of these activities from the program at a particular school.

7. Co-education in college physical education is not a fad nor has it reached its maximum development, but it will continue to increase in significance in our programs.

8. At seventy-four (94%) of the seventy-nine colleges studied, provision is currently made in some phase of the program for co-education.

9. At fifty-eight (73%) of these schools, opportunity for co-education is provided in the organized voluntary program, no credit given.

10. At thirty-seven (47%) of these schools students may elect co-educational classes within the prescribed program, credit given.

11. In fifty (63%) of the seventy-nine colleges studied, co-educational clubs have been organized in various sports. At one particular school co-educational sports clubs in twelve different sports have been formed.

12. At sixty-five (83%) of these schools provision is made for special co-educational events, such as Sport Nites, Folk Dance Frolics, Mixed Swims, Roller Skating Parties, and Play Days.

13. Co-education is finding expression in the weekend recreation programs of colleges whose student body is restricted to one sex.

14. At fifty-one (65%) of the colleges studied, separate gymnasia exist for men and women students. At 54 per cent of these schools provision is made in either the women's or men's gymnasium for dressing and shower facilities for the opposite sex.

Implications of the Study. The college physical education program can be enriched by providing opportunity in the prescribed and voluntary programs for co-education; there are manifold opportunities in both of these programs to develop co-education.

It would appear that if the development of co-education is to be fostered, curricula for the preparation of teachers of physical education must incorporate materials concerning the organization and operation of this type program. No new or distinct courses need be added to the present professional curricula to accomplish this. Existing courses in sport activities, principles, methods, and administration can satisfactorily encompass materials necessary to prepare the students for this aspect of the program.

It would also appear desirable for administrators of college programs to consider possibilities for the development of co-education when planning the construction or improvement of gymnasium and other physical education facilities. It has been pointed out in this study that the limitation of facilities is the most significant factor impeding the development of a co-educational program. Quite often educational philosophy and educational facilities have failed to develop together. Present college physical education programs are handicapped by the gap between accepted philosophy and existing facilities.

If, as suggested by this study, co-education in college physical education is desirable, administrators, along with their staffs, should proceed to foster, shape and direct this development by preparing personnel, providing facilities and leadership, and designing the program to include opportunities for wholesome, satisfying experiences in co-education.

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A Study of the Physical Therapy Activities and Equipment in Veterans' Administration Hospitals

GILBERT R. SHUCK, M. P. E.

THE NEED for physical therapy treatment and activities has been greatly intensified since the end of the second World War by the return of disabled veterans to the universities and civilian life.

Because the need for such treatment is so great, much study has been done in this field. New activities and improved methods of treatment have been discovered, and as a result, the whole physical therapy program has been more effective.

This study is limited to seventeen of the more common ailments listed in the current files of Veterans' Administration Hospitals. The information has been carefully selected and compiled. The writer has made a thorough search for facts on the types of physical therapy equipment used for treating these various disabilities and also the activities assigned for each type of disability. It is hoped this study will assist the physical therapist who is administering treatments in the universities by helping him select the best activity or equipment for a specific ailment, so that, in turn, the student will be rehabilitated in less time and with less disabilities.

It is practically impossible to acknowledge the help of the many individuals in Veterans' Administration Hospitals who contributed to the compilation of these questionnaires and informational materials. Although the following acknowledgements, will, of necessity, be incomplete, appreciation is extended to the personnel of the following Veterans' Administration Hospitals: Muskogee, Oklahoma; Salt Lake City, Utah; Battle Creek, Michigan; Dallas, Texas; Indianapolis, Indiana; Columbia, South Carolina; Dwight, Illinois; Hines, Illinois; Jefferson Barracks, Missouri; Wichita, Kansas; Saratoga Springs, New York; and Lincoln, Nebraska.

Gratitude is expressed to Dr. S. J. Miller, M.D., and Mr. Wellman L. France of Purdue University, who encouraged and suggested the project.

Definition of Terms Used

Arthritis—a condition manifested ordinarily by inflammation of a joint.

Dermatitis—an inflammation of the derma, true skin.

Diathermy—machine used in physical therapy treatment which has a high frequency current. It may be used as a stimulative agent or as a sedative agent. Diathermy generates a continuous and steady heat within the affected parts, causing an increased blood supply to the deeper tissues.

Faradic Current—one of the oldest electrical currents. Its action is mechanical in effect. This current almost secures a normal motor nerve impulse, so it is used to re-educate nerve and muscle connection and for aiding circulation and nutrition which are poor.

Functional Foot Defect—a potential weak foot or disorder, which has not become fixed, for example, flexible flat foot.

Galvanic Current—a machine that causes a chemical action in the nerve endings, aids in relieving pain, stopping hemorrhage, and soothes inflammatory conditions.

Heart Disease (functional)—a functional disorder is a secondary condition derived from disturbances in the body mechanism, for example, murmurs.

Heart Disease (structural)—an organic heart disturbance characterized by a permanent malformation in some cardiac structure, for example, valves.

Heat Cradle—metal bridge-like equipment that can be placed on a bed for heating parts of the body. There are several light bulbs contained within the cradle.

Hemiplegia—a spastic paralysis (condition of hypertension in one set of muscles, which interferes with the normal action of the opposing or antagonistic muscles) involving one side of the body, for example, the right arm and right leg.

Infra-red—a lamp having a short wave that penetrates to the deeper tissues.

Massage—the scientific manipulation or handling of the soft tissues of the body for therapeutic purposes.

Muscular Dystrophy—refers to an atrophication of a muscle or muscles due to paralysis of the part involved.

Neuritis—an inflammation of a nerve.

Osteomyelitis—an inflammation of the bone.

Physical Therapy—includes the employment of the physical and other effective properties of ultra-violet and infra-red radiant energy, heat, cold, water, electricity, therapeutic exercise and massage in the treatment of disease and injury and for diagnostic tests.

Poliomyelitis—Infantile paralysis

Sciatic Rheumatism—a shifting inflammation or neuralgia, affecting the muscles, joints, or other structures in the sciatic region (pelvic and leg).

Scoliosis—a condition in which any series of vertebral spinous processes show a constant deviation from the median line of the body. The deviation may be right or left and functional or structural (curve of the spine).

Sinus—an opening in a bone generally adjacent to the respiratory tract and the seat of sinusitis.

Sitz bath—type of bath generally given for ailments of the pelvic region, for a person sits down in this properly shaped bath tub. It is con-

structed to fit the buttock. The water in the tub is warm enough to promote proper stimulation and relief.

Spinal Fusion—a condition as a result of fusing of the backbones (vertebrae).

Ultra-violet—a machine that produces rays for nourishing and stimulating tissues and relieving of pain. In stronger doses their rays act as bactericides.

Vapor bath—steam bath.

Whirlpool—a tank containing an agitator (propeller) and luke warm water. The object of this equipment is to stimulate circulation and to revitalize the part affected.

The Study

The purpose of the following study is to determine the frequencies and effectiveness of activities and physical therapy equipment assigned to seventeen ailments by Veterans' Administration Hospitals as a basis for suggesting a possible physical therapy program at the universities. An attempt has been made to find the best kind of treatments and activities assigned to the following ailments: One Arm Missing; One Leg Missing; Poliomyelitis; Muscular Dystrophy; Hemiplegia; Heart Diseases (functional); Heart Diseases (structural); Foot Defects (functional); Neuritis; Sciatic Rheumatism; Arthritis; Scoliosis; Dermatitis; Spinal Fusion; Osteomyelitis; Sinus (colds, bronchitis, etc.); Kyphosis; and to rank in order, activities, physical therapy equipment, and the total number of cases of improvement.

To change and improve a physical therapy program, a knowledge of the facts of proper and up-to-date treatments and activities assigned to a particular disease or injury is necessary. The problems to be discussed under this heading will be limited to 1) the number of cases, 2) activities or sports assigned in order of frequency, 3) physical therapy assigned in order of frequency, 4) the number of cases having no, slight, good, or very good improvement, due to the prevailing treatments, 5) frequency of cases (pertaining to location), 6) frequency and order of importance of physical therapy equipment, and 7) total cases and frequency of the total number of cases of improvement.

The tables used in this research are summaries of the information obtained from the various hospitals on types of activities assigned and equipment used in the treatment of these disabilities. In each case an attempt has been made to show in Column 1 of the Table, the activities or sports used in the treatment of the disability for which the table is marked. The activities are ranked in the order of their importance. Since there is a difference in opinion as to the best type of therapy to be used in each case, the report of the findings from each hospital is listed. This is shown in Column 2 of the Table. Each number represents a hospital report. The number one indicates the most effective method used. The number two indicates the second most effective method used, etc. In Column 3 the

degree of improvement shown in the cases studied after the recommended therapy has been administered, is listed

One Arm Missing—Massage, whirlpool, in conjunction with exercise for strengthening the stump, are the most effective treatments used. The facts are that of the total of 7 cases reported, there are 3 of good improvement and 3 of very good improvement. It is possible that the findings would be slightly different if there were more cases available for study.

One Leg Missing—Observing the studies below, it is found that "leg" and "arm" amputees are similar in treatments. Massage, whirlpool, and possibly rhythmic constrictor are most frequently used for the best results.

TABLE 1
One Arm Missing

ACTIVITY OR SPORT ASSIGNED IN ORDER OF EFFECTIVENESS	PHYSICAL THERAPY USED IN ORDER OF EFFECTIVENESS 1, 2, 3,	NUMBER OF CASES OF IMPROVEMENT
1. Exercise for strengthening the stump	Diathermy 1	No 0
2. Occupational therapy	Infra-red 2	Slight 1
	Massage 2, 1, 1, 1	Good 3
	Whirlpool 2, 1	Very good 3
	Ultra-violet 3	
	Exercise 2	Total Cases ... 7

TABLE 2
One Leg Missing

ACTIVITY OR SPORT ASSIGNED IN ORDER OF EFFECTIVENESS	PHYSICAL THERAPY USED IN ORDER OF EFFECTIVENESS 1, 2, 3, 4	NUMBER OF CASES OF IMPROVEMENT
1. Pre-prosthetic training	Diathermy 3,3	No 2
2. Prosthetic training	Infra-red 2,2	Slight 2
3. Hop Scotch	Massage 1, 1, 1, 1, 1, 1	Good 11
4. Golf	Whirlpool 2, 1, 2, 1	Very good 7
	Ultra-violet 4	
	Rhythmic Constrictor 1, 2	Total Cases .. 22

Pre-prosthetic and prosthetic training are the activities most frequently assigned. The results of the number of cases of improvement out of 22 are 11 good and 7 very good.

Poliomyelitis—Infra-red lamp therapy is used most frequently. However, massage and whirlpool are effectively used. Underwater exercise and re-education are subsequent assignments.

Muscular Dystrophy—It is difficult to determine which treatment is most effective in the case of muscular dystrophy. Massage, whirlpool, and activity exercises are used most frequently. Occupational therapy is the most frequent activity assigned. Any improvement would be slow and considered great encouragement. Out of five cases studied, three cases showed slight improvement; one case showed good improvement; and one case showed very good improvement. Because of the relative small number of cases studied, the results might not always be as reported.

Hemiplegia—Reports on hemiplegia indicate that infra-red and active and passive underwater exercises are the most frequently used. Bicycle (stationary) and exercise on stall bars are the activities assigned the most, respectively. The studies further indicate that treatments are progressing by having 50 per cent of the cases with "good or very good" improvement.

Heart Diseases (Functional)—Physical therapy equipment is not used generally for "Heart Diseases." Activities or sports are utilized according to the severeness of the heart ailment. Graded cardiac exercises are as-

TABLE 3
Poliomyelitis

ACTIVITY OR SPORT ASSIGNED IN ORDER OF EFFECTIVENESS	PHYSICAL THERAPY USED IN ORDER OF EFFECTIVENESS 1, 2, 3,	NUMBER OF CASES OF IMPROVEMENT
1. Muscle retraining	Diathermy 3, 2	No 1
2. Occupational therapy	Infra-red 1, 1, 1, 1, 1	Slight 4
3. Walking in a walker	Massage 2, 1, 1	Good 9
4. Swimming	Whirlpool 2, 1, 1	Very good 11
	Ultra-violet 2, 3	
	Galvanic 1	
	Re-education 1, 1, 1	
	Hot packs 1	
	Underwater exercises 2, 1	Total Cases 25

TABLE 4
Hemiplegia

ACTIVITY OR SPORT ASSIGNED IN ORDER OF EFFECTIVENESS	PHYSICAL THERAPY USED IN ORDER OF EFFECTIVENESS 1, 2, 3, 4	NUMBER OF CASES OF IMPROVEMENT
1. Exercise on stall bars	Diathermy 1, 1	No 12
2. Bicycle (stationary)	Infra-red 1, 1, 1, 1, 1	Slight 33
3. Occupational therapy	" 1, 1, 2	Good 30
4. Correct walking	Massage 1, 1, 1, 1, 2	Very good 35
5. Pulley therapy	" 2, 2, 3, 3	
	Whirlpool 1, 1, 3, 3, 4	
	Active and Passive (underwater) exercise 1, 1, 1, 1, 1, 1	
	Re-education 1, 2	Total Cases 110

signed to a person to the extent of his or her disability. Shuffleboard, golf, archery, fishing, and camping are among the sports assigned.

Functional heart disturbance does not indicate illness, but the person's "reserve strength" may not be sufficient to meet the demands of vigorous activity and sudden strain. Being a muscle, the heart needs exercise, as do other muscles of the body. By preventing over-fatigue, through the avoiding of excessive activity, mal-functional heart cases usually disappear. Out of forty cases, five showed no improvement and thirty-five showed only slight improvement.

Heart Diseases (Structural)—In an organic heart disturbance there is a permanent malformation in some part of the cardiac structure. When

the statement is made that organic conditions are permanent, it is meant that malformations of the structure of the valves or muscle cannot be cured, but the infection or toxin which has caused the condition may be eradicated. The scars in the valves or muscles prevent these tissues from becoming normal again.[1]

There are no structural heart disturbances as depicted by the surveys. However, some activities are cited. The general theme of thought is that of moderation of activities. This does not mean that an individual should lead a life of physical inactivity. The physician should estimate an individual's work capacity. Such sports as archery, camping, fishing, rope spinning, boating, shuffleboard, and croquet may be used for this type of ailment. The range of movement may be shortened in certain activities; continuity of action must be reduced to keep within the student's exercise tolerance; adequate rest period should be frequent; the student's natural skill must be taken into consideration.[2]

Foot Defects (Functional Foot—abducted foot, weak foot, flexible flat foot)—There seems to be more emphasis on activities rather than physical therapy for remedial treatment—that is logical since there has been a potential weakness in the plantar aspect of the foot. Heel cord stretching, picking up rocks, and sand walking are assigned, respectively in order of effectiveness. There is a choice of whirlpool and massage as far as physical therapy assignments. Due to the location and type of ailment, not too great an improvement is shown with the prevailing treatments. There are 45.1 per cent cases of slight improvement. Only four of the thirty-one cases studied showed very good improvement. Seven cases showed good improvement; fourteen cases showed slight improvement; and six cases showed no improvement.

Neuritis—There are a multitude of assignments for neuritis. Diathermy and infra-red lamp therapy are used most frequently. Activities that have been used are 1) rehabilitation exercises and 2) range of motion exercises. There is strong evidence that the present treatments are beneficial to the assignees by having 79.9 per cent cases show "good and very good' improvement.

Sciatic Rheumatism—It is understandable that diathermy and infra-red lamp therapy would be utilized the most, since they are deep penetrating, shortwave heating units. Sciatic rheumatism needs that type of treatment, since the sciatic nerve is well protected by external muscles and tissues. Exercises, depending on the degree of severeness, are prescribed as the best activities. Evidences show that there is 81.1 per cent of "good and very good" improvement, which is indicative of substantial assignments to the patients involved. Seventy-four of the 163 cases studied showed good improvement; 43 showed very good improvement. Only 17 did not respond to treatment.

[1] George T. Stafford. *Sports for the Handicapped*. New York: Prentice-Hall Inc., 1947, p. 159.
[2] *Ibid.*, p. 159.

Arthritis—There seem to be pronounced utilization of a variety of treatments, yet some assignments are outstanding. Infra-red seems to be the most utilized machine. Diathermy, massage, and whirlpool are mentioned in order of frequency, respectively. Activities of 1) exercise, depending on the severeness of the case; 2) exercise on the stall bars, and 3) shoulder wheel are reported being assigned in order of their frequency. There is no

TABLE 5
Neuritis

ACTIVITY OR SPORT ASSIGNED IN ORDER OF EFFECTIVENESS	PHYSICAL THERAPY USED IN ORDER OF EFFECTIVENESS 1, 2, 3, 4, 5	NUMBER OF CASES OF IMPROVEMENT
1. Rehabilitation exercises	Diathermy.....1, 2, 1, 1, 1	No..... 0
2. Range of motion exercises	Infra-red.....1, 2, 1, 1, 2	Slight..... 38
3. Shoulder wheel	Massage.....3, 1, 3, 3	Good..... 103
	Whirlpool.....2, 1, 2	Very good... 45
	Ultra-violet.....2, 1	
	Galvanic..... 4	
	Cabinet bath.....5, 1	
	Exercise.....4, 2	Total Cases.. 186

TABLE 6
Arthritis

ACTIVITY OR SPORT ASSIGNED IN ORDER OF EFFECTIVENESS	PHYSICAL THERAPY USED IN ORDER OF EFFECTIVENESS 1, 2, 3, 4, 5, 6, 7, 8	NUMBER OF CASES OF IMPROVEMENT
1. Exercises, depending on degree of severeness	Diathermy 1, 4, 2, 2	No..... 88
2. Exercise, stall bars	" 1, 2, 1	Slight..... 89
3. Shoulder wheel	Infra-red 2, 1, 1, 1	Good..... 349
4. Rowing machine	" 1, 1, 1, 2	Very good... 113
	Massage 1, 1, 1, 3	
	" 3, 3, 4, 5	
	Whirlpool.....1, 2, 2, 2	
	" 4, 4, 6	
	Ultra-violet.....1, 4, 7	
	Cabinet bath.....2, 3	
	Exercises (Passive).....1, 2, 2, 5	
	Heat Cradle.....3, 8	Total Cases... 639

doubt as to the effectiveness of the prevailing treatments—having 72.3 per cent of cases with "good and very good" improvement.

Scoliosis (Functional and Structural)—Most of the treatments given are pertaining to exercises—asymmetrical and postural. Lateral curvature is a progressive process of affection, halted by the resistance offered by the tissues, bones, ligaments, and muscles. If the affection is allowed, it becomes a fixed structural or organic form of curvature. The latter type of affection is very difficult to cure. Having a 62.5 per cent of "no" improvement indicates the difficulty of favorable prognosis. Ten of the sixteen cases studied showed no improvement and the other six cases showed only slight improvement. Again, if more cases were studied, findings might vary from the above report.

Dermatitis—Physical therapy seems to be the only prevailing assignment for treating skin disorders. Ultra-violet is definitely the most effective treatment. Forty-six of the 102 cases showed very good improvement and thirty-four others showed good improvement. Only five did not respond to treatment.

Spinal Fusion—Forced flexion exercises seem to be the only type of activity assigned. Massage and infra-red are the two assignments most frequently made. By utilizing these types of treatments, 50 per cent of the cases showed good and very good improvement. That percentage is excellent considering that a fixation may have resulted in some of the 32 cases. Six of the thirty-two cases did not respond to the treatment.

Osteomyelitis—It is rather common to perform surgical operations on such cases as osteomyelitis. The malignancy of the ailment determines the type of treatment it should receive. Most patients of osteomyelitis

TABLE 7

Sinus (related illnesses)

ACTIVITY OR SPORT ASSIGNED IN ORDER OF EFFECTIVENESS	PHYSICAL THERAPY USED IN ORDER OF EFFECTIVENESS 1, 2, 3, 4		NUMBER OF CASES OF IMPROVEMENT	
None used	Diathermy	1, 1, 1, 1, 1	No	7
	Infra-red	1, 1, 2, 3	Slight	2
	Ultra-violet	1, 1, 2, 3	Good	39
	Massage	2	Very good	67
	Exercises	4	Total Cases	115

improve slowly. If a case has not progressed too far, there are beneficial results deriving from physical therapy administration. Evidences are that 76.8 per cent had "slight and good" improvement. Whirlpool therapy is used most frequently. These findings are based on the thirteen cases studied.

Sinus, Colds, Bronchitis, (etc.)—Inspecting the accumulative data, physical therapy seems to be the main issue for treatment with diathermy having the most frequent assignments. Infra-red and ultra-violet are second in place as to use. The treatments used seem to be effective as 92.1 per cent of the cases show "good and very good" improvement.

Kyphosis (Round Shoulders)—Kyphosis, generally speaking, is a functional defect, however, it may become structural if proper treatment is not performed at the proper age. Physical therapy machines would not have very much effect upon this type of ailment. Activities and a few special sports obtain the optimum results. Corner exercises, lunge forward exercises, trunk rising against resistance, breast stroke in swimming, and volleyball are good assignments to aid in correction of round shoulders Such activities and sports have to be used during the growth and development stage of an individual to get the best results. No cases of kyphosis were being treated in the hospitals surveyed.

Summary

ORDER OF IMPORTANCE OF PHYSICAL THERAPY EQUIPMENT

In checking the order of importance of physical therapy equipment, there is a positive correlation throughout the Veterans' Administration Hospitals making this report. The following summary lists in the order of their importance the types of equipment needed for a physical therapy program and the disabilities or disorders for which the equipment is most effectively used.

Equipment	Most Valuable Therapeutic Use
1. Infra-red	Hemiplegia, arthritis, sciatic rheumatism, polio
2. Diathermy	Arthritis, sciatic rheumatism, sinus (related), neuritis
3. Massage table	One leg missing, one arm missing, hemiplegia, arthritis
4. Whirlpool	Muscular dystrophy, polio, osteomyelitis, arthritis
5. Ultra-violet	Dermatitis, sinus (related), neuritis
6. Cabinet	Neuritis, arthritis
7. Shoulder wheel	Neuritis, arthritis
8. Stall bars	Arthritis, neuritis
9. Bicycle (Stationary)	Hemiplegia, foot defects (functional)
10. Faradic and Galvanic	Polio, sciatic rheumatism
11. Sitz bath	Sciatic rheumatism
12. Heat cradle	Arthritis

A Study of Degrees and Ranks Held and the Graduate Credit Offerings Taught by Men and by Women in Physical Education*

JANE S. MCILROY
Southern Idaho College of Education
Albion, Idaho

ACCREDITING agencies and associations concerned with the scholarly attainment and professional status of graduate faculty in all fields of higher learning have, over a period time, recommended standards for individuals teaching on the graduate level. These agencies and associations in general agree that graduate faculty members should demonstrate teaching and research ability, and have a high level of scholarship. They have recommended, also, that the graduate faculty members hold doctoral degrees or the equivalent, and the rank of assistant professor or above (1–3).

In reference to terms used in this study, graduate credit offerings may be defined as strictly graduate offerings for graduate students only, in addition to those undergraduate courses identified in the catalogues of the institutions of higher learning as carrying graduate credit. The term academic degrees refers to earned degrees, such as the Doctor of Philosophy, Doctor of Education, Master of Arts, Master of Science, Bachelor of Arts, and Bachelor of Science.

The purpose of the present study was to compare the scholarly attainment and the professional status of men with that of women teaching physical education on the graduate level in universities, in colleges, and in teacher's colleges. This comparison was specifically based upon:

1. The degrees held by men and by women.
2. The faculty rank held by men and by women.
3. Graduate credit offerings taught by men and by women holding various types of degrees and ranks.

Specific studies of the scholarship and professional status of men and women teaching physical education on the graduate level were made particularly from the year 1935 to date by H. Harrison Clarke (4), Norris and Sweet (7), Jack Hewitt (6), and Loren Tuttle (8) who did much to portray the professional status of the graduate faculty. These studies dealt primarily with the degrees and faculty rank held by the graduate faculty as a whole, with little regard for division of staff into sections of men

* An abstract of a thesis for the master of science degree presented to the School of Health and Physical Education and the Graduate School, University of Oregon, August, 1949.

and of women. Although Norris and Sweet did attempt such a division, their results, according to their own admission, lacked reliability.

It seemed important that this study be undertaken to fulfill the need for more recent and reliable specific information than that presented by Norris and Sweet, and by the other studies. It makes an effort to show prevailing practices in some eighty seven institutions regarding scholarship and rank of men and of women graduate faculty members.

TABLE 1

297 Graduate faculty members and 719 graduate credit offerings taught in 57 institutions of higher learning

57 Institutions

	MEN		WOMEN		MEN & WOMEN	
	No.	%	No.	%	No.	%
Graduate Faculty	196	66.0	101	34.0	297	100.0
Graduate Offerings	484	67.3	235	32.7	719	100.0

TABLE 2

296 Graduate faculty members teaching 718 graduate credit offerings according to type of institution

56 Institutions*

	UNIVERSITIES (41)						COLLEGES (15)						MEN & WOMEN			
	Men		Women		Men & Women		Men		Women		Men & Women		Universities		Colleges	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Graduate Faculty	158	68.4	73	31.6	231	100.0	37	56.9	28	43.1	65	100.0	231	78.0	65	22.0
Graduate Offerings	372	70.0	159	29.9	531	100.0	111	59.3	76	40.6	187	100.0	531	73.9	187	26.1

* Omission of data from the Teacher's Colleges. (See Summary of Findings, item 3.)

Source, Nature, and Treatment of Data

Data included in this study were obtained from the 1947–48 catalogues of eighty-six of the eighty-seven institutions offering graduate study programs in physical education as collected by Loren Tuttle for use in his study of graduate practices, and from short personal letters and questionnaires sent to the department heads in twenty institutions whose catalogues contained insufficient information in this respect.

The data, as shown in twelve tables of the original thesis, are on a number and percentage basis. These tables refer to the graduate staff and indicate academic degrees and faculty rank held, and graduate credit offerings taught by men and by women in the universities, in the colleges, and in the teacher's colleges.

The following four tables were selected from the original thesis on the basis of general interest and ease of reproduction.

TABLE 3

Degrees held by 297 graduate faculty members
57 Institutions

DOCTOR'S DEGREE			MASTER'S DEGREE			BACHELOR'S DEGREE			DEGREE NOT GIVEN		NO DEGREE	
Degree title	No.	%	Degree title	No.	%	Degree title	No.	%	No.	%	No.	%
					Men†							
Men: No. 196												
M.D.	8	4.1	M.A.	45	22.9	B.A.	14	7.1				
Ph.D.	46	23.5	M.S.	29	14.8	B.S.	10	5.1				
Ed.D.	17	8.7	M.Ed.	11	5.6	B.P.E.	—	—				
D.O.*	1	.5	M.P.E.	3	1.5	B.E.	1	0.5				
L.L.D.	2	1.0				B.C.S.	1	0.5				
Sc.D.	2	1.0										
									5	2.5	1	0.5
Total	76	38.8		88	44.9		26	13.2	5	2.5	1	0.5
					Women†							
Women: No. 101												
M.D.	3	2.9	M.A.	40	39.6	B.A.	3	2.9				
Ph.D.	21	20.8	M.S.	18	17.8	B.S.	3	2.9				
Ed.D.	5	4.9	M.Ed.	5	4.9	B.P.E.	—	—				
D.O.*	—	—	M.P.E.	—	—	B.E.	—	—				
L.L.D.	—	—				B.C.S.	—	—				
Sc.D.	—	—										
									2	2.0	1	1.0
Total	29	28.7		63	62.3		6	5.9	2	2.0	1	1.0

Degree Summary
Men and Women

DEGREE TITLE	TOTAL NUMBER	TOTAL PER CENT	RANK ORDER
Doctor's	105	35.3	2
Master's	151	50.8	1
Bachelor's	32	10.8	3
Degree Not Given	7	2.3	4
No Degree	2	0.7	5
Total	297	100.0	

* Doctor of Osteopathy.
† Percentages based upon men among men and women among women.

SUMMARY OF FINDINGS

A summary of these findings shows that in general there are approximately twice as many men in institutions of higher learning teaching

twice as many graduate credit offerings as women. This same situation holds true for each separate type of institution, as university and college. In the overall percentage picture, the men and the women are in approximate equal status in respect to those who hold specific academic degrees and faculty rank, with, however, the men meeting the recommended degree and rank standard to a slightly greater extent than the women. Variations of this close equality may be noted in the breakdown of listings in the percentages of degrees and of ranks held in the universities and colleges. In greater detail the summary presents the following data:

1. More men (66%) than women (34%) are teaching graduate offerings in physical education, thus more graduate offerings are taught by men (67%) than by women (33%). However, it may be noticed that the ratio

TABLE 4

Faculty rank held by 297 graduate faculty members

57 Institutions

Women: No. 101 Men: No. 196

FACULTY RANK	MEN†		WOMEN†		MEN & WOMEN	
	No.	%	No.	%	No.	%
Professor	75	38.3	24	23.8	99	33.3
Associate	39	19.9	23	22.8	62	20.9
Assistant	43	21.9	27	26.7	70	23.6
Instructor	23	11.7	16	15.8	39	13.1
Other*	12	6.1	10	9.9	22	7.4
Rank Not Given	4	2.0	1	1.0	5	1.7
Total	196	100.0	101	100.0	297	100.0

* Lecturer, Supervisor, Assistant and Associate in Physical Education, Part-time and Visiting Instructor.

† Percentages based upon men among men and women among women.

between individuals teaching and offerings taught remains approximately the same in the case of both the men and the women (Table 1).

2. A greater percentage of graduate instructors, men and women, are on university faculties (78%) than on college faculties (22%), likewise, more graduate offerings are taught in universities (74%) than in colleges (26%). It can thus be seen that the college faculties are responsible for more offerings per instructor than are the university faculties. (Table 2).

3. No comparative percentages of degrees, faculty rank, and graduate offerings could be obtained from data available from the teacher's colleges because of insufficient information contained in the catalogues of those institutions.

4. The graduate faculty men came closer to meeting the degree standard recommended by the agencies and associations concerned with graduate programs than did women. (*Doctor's Degree:* men 39%, women 29%; *Master's Degree:* men 45%, women 62%; *Bachelor's Degree:* men 13%, women 6%.) The men also came closer to meeting the recommended faculty

rank standard than did the women. (*Professor, Associate Professor, and Assistant Professor Rank:* men 80%, women 73%.) (Tables 3 & 4.)

5. The graduate faculty, men and women, came much closer to meeting the recommended standard of rank than of degrees. (Tables 3 & 4).

6. With respect to graduate credit offerings taught, men came closer to meeting the degree standard than women. (*Doctor's Degree:* offerings taught by men 51%, by women 34%; *Master's Degree:* offerings taught by men 38%, by women 58%; *Bachelor's Degree:* offerings taught by men 9%, by women 5%.) Likewise, concerning graduate offerings taught, men came closer to meeting the rank standard than did women. (*Professor, Associate Professor, and Assistant Professor:* offerings taught by men 86%, by women 77%.

7. In relation to the above mentioned graduate offerings, the men and the women came much closer to meeting the recommended standard of faculty rank than of academic degrees. (Refer to item 6.)

8. The university faculty men came closer to meeting the degree standard than the college women, the university women, and the college men. (*Doctor's Degree:* university men 43%, college women 39%, university women 25%, college men 19%; *Master's Degree:* university men 42%, college women 54%, university women 66%, college men 59%; *Bachelor's Degree:* university men 13%, college women 0%, university women 8%, college men 16%.) Concerning the college men and the college women, it may be stated that they came closer to meeting the recommended rank standard than the university men and the university women. (*Professor, Associate Professor, and Assistant Professor Rank:* college men 86%, college women 86%, university men 78%, university women 68%.)

9. In reference to graduate credit offerings taught, the university faculty men came closer to meeting the degree standard than did the college women, the university women, and the college men. (*Doctor's Degree:* offerings taught by university men 56%, by college women 43%, by university women 29%, by college men 34%; *Master's Degree:* offerings taught by university men 35%, by college women 51%, by university women 62%, by college men 49%; *Bachelor's Degree:* offerings taught by university men 8%, by college women 0%, by university women 8%, by college men 11%.) Whereas, with respect to faculty rank, the college faculty, men and women, came closer to meeting the recommended standard than the university faculty, men and women. (*Professor, Associate Professor, and Assistant Professor Rank:* offerings taught by college men 91%, by college women 84%, by university men 84%, by university women 74%.)

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The Acute Effect of Smoking Upon the Physical Performance of Habitual Smokers

WARREN E. REEVES AND LAURENCE E. MOREHOUSE
University of Southern California, Los Angeles

DOES SMOKING hinder athletic performance? Many coaches and trainers say that it does while others in the field of athletics maintain that there is no immediate effect from smoking. Previous studies show variable effect of smoking upon speed and accuracy of manipulative activities (1, 2, 4–6). Smoking was shown to prolong recovery after double periods of work using a hand dynamometer (10). When this study was repeated using more careful controls, no effect on recovery due to smoking was noted (7). These studies are summarized in Table 1.

PROBLEM

It was the purpose of this investigation to study the acute effect of smoking upon some of the physiological components of athletic performance in habitual smokers.

METHOD

In order to study the acute effect of smoking upon the physical performance of habitual smokers, fifteen college students who were habitual smokers volunteered as subjects for the study. Fourteen of the subjects were men and one was a woman. Tests of speed, strength, agility, and endurance were administered to all subjects under two conditions. Condition (a) was a non-smoking period two hours prior to the test. Condition (b) was inhaling 2.7 liters of smoke from one cigarette.

APPARATUS

In order to control the amount of smoke inhaled by the subjects during the experiment, a smoking device was constructed. This device is shown in Figure I. It consisted of a mouthpiece (*g*) connected to a chamber (*e*) containing flutter valves (*d*) which directed the flow of smoke through an aperture (*f*) into the subject's respiratory cavity upon inhalation. During exhalation, the expired air passed through a tube connecting the pipe (*h*) with a gasometer. A lighted cigarette was placed in the aperture of the smoking device (*a*). The subject inhaled smoke through the cigarette which was mixed with air drawn through the small opening (*b*) at the end of the device. Most of the subjects consumed three-fourths of a cigarette during the process which required three to four minutes. The location of the right intake valve (*d*) prevented exhaled air from increasing the com-

TABLE 1

Summary of studies of the acute effect of smoking on physical performance

TEST	RESULTS AFTER SMOKING	REFERENCE
Speed and accuracy of sorting playing cards	Slight decrease in accuracy	Carver (2)
Accuracy of throwing darts	Negligible to slight decrease of accuracy	Bates (1)
Prolonged tapping of telegraph key at maximum rate	Slight increase in speed and endurance	Hull (6)
Speed and accuracy of simple and choice reactions to colored lights	Increased speed and accuracy	Fisher (5)
Repeated measurement of grip strength. Non-smoking test administered 2 days after smoking test	Lower degree of recovery after smoking. (May be ascribed to beneficial effect of training on non-smoking test)	Willgoose (10)
Repetition of Willgoose study. Used placebo and randomized series.	No effect on recovery from fatigue.	Kay and Karpovich (7)

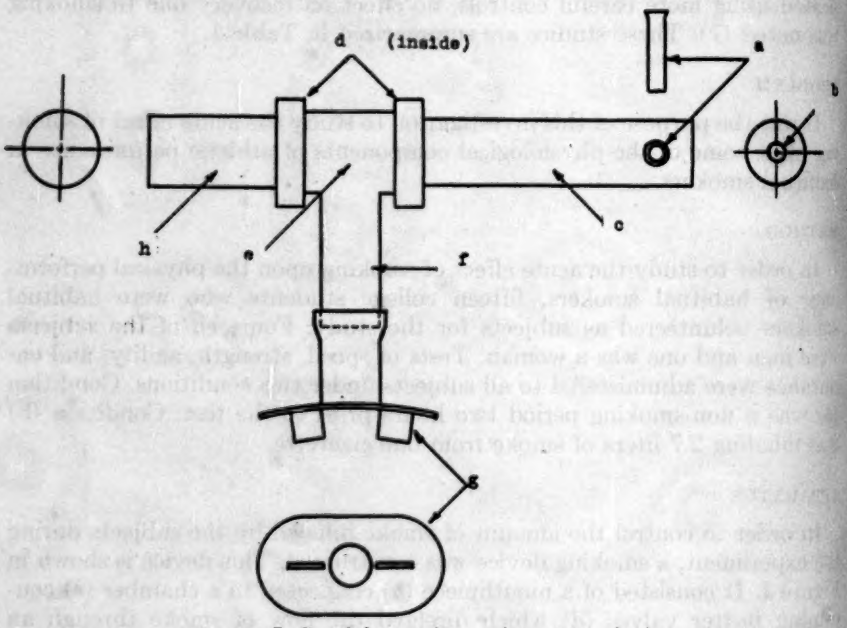

FIGURE I. Special experimental smoking device
a—cigarette holder
b—air opening
c—air intake pipe
d—flutter valves (rubber)
e—valve chamber
f—mouth pipe
g—mouth piece (rubber)
h—air escape pipe all parts brass except those noted
Scale: 0.5″ equal 1.0″

bustion of the cigarette. The subjects reported irritation of the upper respiratory tract during and immediately after smoking. It was observed that the subjects increased salivation markedly during smoking.

PROCEDURE

Each subject reported to the laboratory on alternate successive days at approximately the same time. The activity of each subject preceding the test sessions was identical. The subject was seated and connected to the smoking apparatus. On the non-smoking day (condition a) the cigarette in the device was unlighted. On the smoking day (condition b) the cigarette was lighted. The order of conditions (a) and (b) was alternated to control as far as possible the effects of fatigue, training, and familiarity with the procedure. In each instance, after 2.7 liters of gas had been exhaled into

TABLE 2

Summary of Variation among test scores in the two conditions of non-smoking and smoking before performance

TEST	MEAN SCORES		DIFFERENCE BETWEEN NON-SMOKE AND SMOKE	"t"	LEVEL OF CONFIDENCE
	Non-smoke	Smoke			
					%
Tapping (taps per sec.)	9.5	9.3	0.2	0.833	40
Sargent Jump (inches)	24.1	24.0	0.1	0.415	70
Grip Strength (kgs.)	78.2	78.6	—0.4	0.289	80
Push Strength (pounds)	93.2	92.4	0.8	0.352	70
Step Test Score (points)	70.3	68.3	2.0	0.729	50
Pulse Rate after Step Test (per 30 secs.)	65.6	68.6	—3.0	0.958	40
Duration of Stepping Exercise	250.0	257.0	—7.0	0.786	40

the gasometer, the subject was disconnected from the apparatus and was given the physical performance tests.

TESTS

A battery of tests of physical performance was administered in the order in which they are described below:

The tapping test, a test of speed of voluntary movements, was used to measure the functional condition of the central nervous system. The subjects tapped a telegraph key as rapidly as possible for five seconds. The taps were recorded on a moving kymograph upon which one-second time marks had been previously recorded. The highest rate during any one second was recorded as the rate of tapping.

Strength was measured by recording maximum efforts on a grip and a push dynamometer using standard procedures (3). Each subject was allowed five trials on each instrument. The highest reading was recorded in both instances.

The Sargent Jump was used to measure muscular power, or the ability to exert a large force in a short time. The jump and reach type of apparatus was used in the conventional form (8).

The Short Form of the Harvard Step Test (9) was employed to measure endurance of the subjects and to measure the degree of displacement of physiological homeostasis.

RESULTS

A statistical summary of the results of the tests given under the two conditions of the experiment appears in Table 2. The test scores achieved under the two conditions were compared. None of the scores showed a statistical difference or a level of confidence high enough to indicate the smoking before the tests had any immediate effect upon performance.

SUMMARY AND CONCLUSIONS

Fifteen habitual smokers inhaled cigarette smoke just before performing tests of speed, strength, power, and endurance. They repeated the tests after refraining from smoking. The results of the tests support the following conclusions:

1. Smoking does not appear to have any influence upon the performance of any of the tests of maximum rate of voluntary movement, muscular strength and power, or cardiovascular fitness for strenuous endurance type of exercise.

2. Apparently, if a person is a habitual smoker, it makes no difference in his physical performance whether he abstains from smoking for a few hours before performing or whether he smokes up to the start of the event.

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Grip Strength Norms for Males

KARL W. BOOKWALTER

Assisted by Ben Bruce, Cecil Cameron, Grace I. Fox, Virginia L. Hoffman, Pete Newquist, David Rains, Merle Rousey

Indiana University,

Bloomington, Indiana

IT IS THE purpose of this study to analyze male grip strengths by age, by weight classes, and by Classification Index[1] groupings.

Grip strength is one of the most reliable dynamometrical measures of human strength. It is a relatively economical measure, is easily administered and is a direct measure of applied force. Accordingly grip strength is a likely component of strength batteries, a strength item in a "fitness" battery, or single item reasonably representative of total body strength.

Profiles were made of the mean and standard deviation through each interval in the age, weight classes, and Classification Index divisions, to show graphically the relationship of increased age, weight, and Classification Index to grip strength. The standard deviation limits are indicated by dotted lines.

Achievement scales have been established for each hand for each age from 9 to 24 and up; for weight groups from up to 69 pounds and to 210 pounds and up, in decile groups; and for Classification Index I groups from up to 594 to 980 and up, in intervals of 35 points of Index. There is evidence that norms should be established for Wetzel's[2] developmental levels and physique classifications, but this awaits further study. No effort has been made to indicate a superior basis for classifying for grip strength. Instead, it is the object of this study to make norms available by age, weight, and Classification Index.

The six sigma formula is employed in each scale and the frequencies for all aspects of the study follow. In this procedure the mean is set at 50 scale score points and the raw score equivalent for each scale score is determined as indicated at the top of each scale.

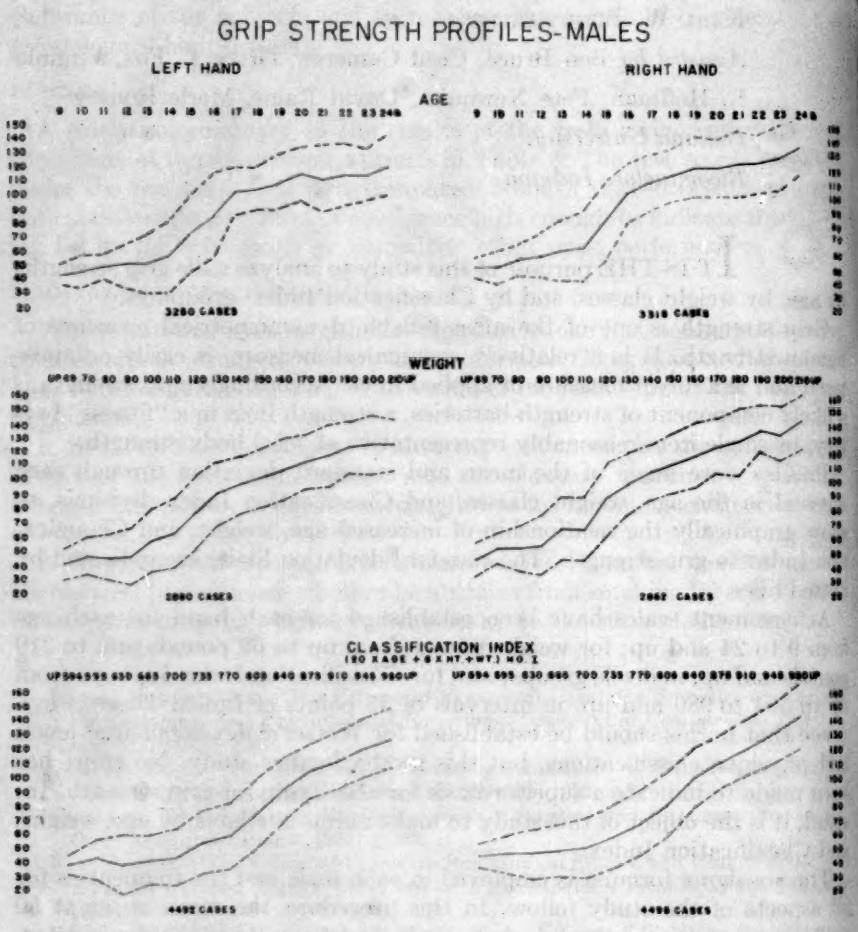
Sampling

The data for this study were collected from several states (Colorado, Illinois, Indiana, Kentucky, and Missouri) and aspects of the study were undertaken by the several authors at different times. The frequencies are

[1] Charles H. McCloy, *The Measurement of Athletic Power*, A. S. Barnes and Company, New York, 1932, p. 119.

[2] Norman C. Wetzel, *Instruction Manual In the Use of the Grid for Evaluating Physical Fitness*. N. E. A. Service, Cleveland, 1941.

not the same for the different parts of the study but it is felt that a sufficient sample is involved in any mean or deviation to give reasonable assurance of practicable stability to the scales.



LEFT GRIP STRENGTH OF MALES BY AGE

The left mean grip strength of males from ages 9 through 24 and up tends generally to increase with age. Slight progression occurs in mean grip strength from ages 9 to 14. Progression accelerates from 14 to 17 years with the greatest increases at 16 and 17 years. A few small irregularities in mean strength appear between 17 and 24 years and up when progression is

slower. But a plateau starts at approximately 17 years of age. The 9 year olds have the smallest mean grip strength, 42 pounds, and the oldest men have the greatest mean grip strength, 121 pounds.

Left hand grip by age shows more irregularity and varied variability than the right hand grip. The least variability and the smallest mean grip strength is between the ages of 9 to 11, where the number of cases is small. Wider variability occurs from 12 years on with the greatest variability during the 14 to 17 years range of mean strength acceleration. The 14 to 17 years range includes the rapid growth years. The left hand mean grip strengths are less than the right hand mean grip strengths for every age group. The difference at regular increments ranges from 5 to 14 pounds.

Frequencies of cases in various age, weight, and classification index groups

Age

	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24-UP	TOTAL
LH	35	48	62	178	340	523	386	251	269	502	237	103	98	95	38	85	3250
RH	36	49	63	188	346	501	393	264	270	516	226	130	104	115	41	74	3316

Weight

	UP TO 69	70–9	80–9	90–9	100–9	110–9	120–9	130–9	140–9	150–9	160–9	170–9	180–9	190–9	200–9	210-UP	TOTAL
LH	73	126	203	292	278	280	349	359	270	214	144	101	60	45	35	31	2860
RH	73	126	203	292	278	280	351	358	270	214	145	101	60	45	35	31	2862

Classification Index I

	UP TO 594	595–629	630–64	665–99	700–34	735–69	770–804	805–39	840–74	875–909	910–44	945–79	980-UP	TOTAL
LH	35	55	113	213	291	339	327	334	521	1027	837	318	82	4492
RH	35	55	112	213	291	339	327	334	521	1028	838	321	82	4496

RIGHT GRIP STRENGTH OF MALES BY AGE

The right mean grip strength of males from ages 9 through 24 and up tends generally to increase with age. Slow, regular progression in mean grip strength occurs from ages 9 to 14. Progression accelerates from 14 through 16 years with the greatest increase at 16 years. Beyond 16 years progression is slower, but regular through 23 years, with a rise occurring at the last interval, 24 years and up. However, there tends to be a plateau beyond 16 years, although less pronounced than for the left hand. Right hand mean grip strength by age shows less irregularity in progression than the left hand grip. The least variability is at the 9 year old interval, where the number of cases is small. Wider variability occurs from 13 years on. The 9 and 10 year olds have the smallest mean grip strengths, 43 pounds and 49 pounds, and the oldest men have the greatest mean grip strengths, 135 pounds. After 14 years the variability of the age groups differ only slightly.

6σ/100 left grip strength scales for males by age

SCALE SCORE	AGE																SCALE SCORE
	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
100	65	78	76	95	112	130	154	175	154	148	166	170	181	180	169	183	100
99	64			94	111	128	153	173	153	147	165	169	179	178	168	182	99
98		77	75	93	109	127	151	171	152	146	164	168	178	177	167	181	98
97		76		92	108	125	150	169	151		163	166	176	176	166	180	97
96	63		74	91	107	124	148	167	150	145	162	165	175	174	165	178	96
95		75		90	106	122	145	166	149	144	160	164	174	173	164	177	95
94	62	74	73	89	104	120	145	164	148	143	159	163	172	172	163	176	94
93			72	88	103	119	143	162	147	142	158	162	170	170	162	175	93
92	61	73		87	102	118	141	160	146	141	157	161	169	169	161	173	92
91		72	71	86	101	116	140	158	145	140	156	160	168	168	159	172	91
90	60				100	115	138	157	144	139	154	159	167	167	158	171	90
89		71	70	85	98	113	136	155	142	138	153	157	165	165	157	170	89
88	59	70		84	97	112	135	153	141		152	156	164	164	156	168	88
87			69	83	96	110	133	151	140	137	151	155	162	163	155	167	87
86		69		82	95	109	131	150	139	136	150	154	161	161	154	166	86
85	58	68	68	81	93	107	130	148	138	135	149	153	160	160	153	165	85
84			67	80	92	106	128	146	137	134	148	152	158	159	152	163	84
83	57	67		79	91	104	127	144	136	133	146	151	157	157	151	162	83
82		66	66	78	90	103	125	142	135	132	145	150	156	156	150	161	82
81	56			77	88	101	123	141	134	131	144	149	154	155	148	160	81
80		65	65		87	100	122	139	133	130	143	148	153	153	147	158	80
79	55	64		76	86	99	120	137	132		142	147	151	152	146	157	79
78		63	64	75	85	97	118	135	131	129	141	146	150	151	145	156	78
77	54		63	74	84	96	117	134	130	128	139	144	148	149	144	155	77
76		62		73	82	94	115	132	129	127	138	143	147	148	143	153	76
75		61	62	72	81	93	113	130	128	126	137	142	146	147	142	152	75
74	53			71	80	91	112	128	127	125	136	141	144	145	141	151	74
73		60	61	70	79	90	110	126	126	124	135	140	143	144	140	150	73
72	52	59		69	77	88	109	125	125	123	134	139	142	143	139	148	72
71			60	68	76	87	107	123	124	122	132	138	140	141	137	147	71
70	51	58			75	85	105	121	123		131	137	139	140	136	146	70
69		57	59	67	74	84	104	119	122	121	130	136	137	139	135	145	69
68	50		58	66	72	82	102	118	121	120	129	134	136	137	134	143	68
67		56		65	71	81	100	116	120	119	128	133	135	137	133	142	67
66			57	64	70	79	99	114	119	118	127	132	133	135	132	141	66
65	49	55		63	69	78	97	112	118	117	126	131	132	133	131	140	65
64		54	56	62	68	76	95	110	117	116	124	130	130	132	130	138	64
63	48	53		61	66	75	94	109	116	115	123	129	129	131	129	137	63
62			55	60	65	73	92	107	115	114	122	128	128	129	128	136	62
61	47	52	54	59	64	72	90	105	114		121	127	126	128	126	135	61
60		51			63	70	89	103	113	113	120	126	125	127	125	133	60
59	46		53	58	61	69	87	102	112	112	118	125	124	126	124	132	59
58		50		57	60	67	86	100	111	111	117	124	122	124	123	131	58
57	45	49	52	56	59	66	84	98	110	110	116	122	121	123	122	130	57
56				55	58	64	82	96	108	109	115	121	119	122	121	128	56
55		48	51	54	56	63	81	94	107	108	114	120	118	120	120	127	55
54	44	47		53	55	62	79	93	106	107	113	119	116	119	119	126	54
53			50	52	54	60	77	91	105	106	112	118	115	118	118	125	53
52	43	46	49	51	53	59	76	89	104		110	117	114	116	117	123	52
51				50	51	57	74	87	103	105	109	116	112	115	115	122	51

6σ/100 left grip strength scales for males by age

SCALE SCORE	AGE																SCALE SCORE
	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
50	42		48	49	50	56	72	86	102	104	108	115	111	114	114	121	50
49		44			49	54	71	84	101	103	107	114	110	112	113	120	49
48	41	43	47	48	48	53	69	82	100	102	106	112	108	111	112	118	48
47				47	47	51	68	80	99	101	105	111	107	110	111	117	47
46	40	42	46	46	45	50	66	78	98	100	104	110	105	108	110	116	46
45		41	45	45	44	48	64	77	97	99	102	109	104	107	109	115	45
44				44	43	47	63	75	96		101	108	103	106	108	113	44
43	39	40	44	43	42	45	61	73	95	98	100	107	101	104	107	112	43
42		39		42	40	44	59	71	94	97	99	106	100	103	106	111	42
41	38		43	41	39	42	58	70	93	96	98	105	98	102	104	110	41
40		38			38	41	56	68	92	95	96	104	97	100	103	108	40
39	37	37	42	40	37	39	54	66	91	94	95	103	96	99	102	107	39
38				39	36	38	53	64	90	93	94	102	94	98	101	106	38
37	36	36	41	38	34	36	51	62	89	92	93	100	93	96	100	105	37
36		35	40	37	33	35	50	61	88	91	92	99	92	95	99	103	36
35	35			36	32	33	48	59	87		91	98	90	94	98	102	35
34		34	39	35	31	32	46	57	86	90	90	97	89	92	97	101	34
33		33		34	29	30	45	55	85	89	88	96	87	91	96	100	33
32	34		38	33	28	29	43	53	84	88	87	95	86	90	95	98	32
31		32		32	27	27	42	52	83	87	86	94	85	88	93	97	31
30	33	31	37		26	26	40	50	82	86	85	93	83	87	92	96	30
29			36	31	24	24	38	48	81	85	84	92	82	86	91	95	29
28	32	30		30	23	23	37	46	80	84	83	90	80	84	90	93	28
27		29	35	29	22	22	35	45	79	83	81	89	79	83	89	92	27
26	31			28	21	20	34	43	78		80	88	78	82	88	91	26
25		28	34	27	20	19	32	41	77	82	79	87	76	81	87	90	25
24	30	27		26	18	17	30	39	76	81	78	86	75	79	86	88	24
23			33	25	17	16	29	37	74	80	77	85	74	78	85	87	23
22		26		24	16	14	27	36	73	79	76	84	72	77	84	86	22
21	29	25	32	23	15	13	26	34	72	78	74	83	71	75	82	85	21
20			31		13	11	24	32	71	77	73	82	69	74	81	83	20
19	28	24		22	12	10	22	30	70	76	72	81	68	73	80	82	19
18		23	30	21	11	8	21	29	69	75	71	80	66	71	79	81	18
17	27	22		20	10	7	19	27	68		70	78	65	70	78	80	17
16			29	19	8	5	18	25	67	74	69	77	64	69	77	78	16
15	26	21		18	7	4	16	23	66	73	68	76	62	67	76	77	15
14		20	28	17	6	2	14	21	65	72	66	75	61	66	75	76	14
13	25		27	16	5	1	13	20	64	71	65	74	60	65	74	75	13
12		19		15	4		11	18	63	70	64	73	58	63	73	73	12
11	24	18	26	14	2		10	16	62	69	63	72	57	62	71	72	11
10					1		8	14	61	68	62	71	55	61	70	71	10
9		17	25	13			6	13	60	67	60	70	54	59	69	70	9
8	23	16		12			5	11	59		59	68	53	58	68	68	8
7			24	11			3	9	58	66	58	67	51	57	67	67	7
6	22	15	23	10			2	7	57	65	57	66	50	55	66	66	6
5		14		9			1	5	56	64	56	65	48	54	65	65	5
4	21		22	8				4	55	63	55	64	47	53	64	63	4
3		13		7				2	54	62	54	63	46	51	63	62	3
2	20	12	21	6					53	61	52	62	44	50	62	61	2
1				5					52	60	51	60	43	49	60	60	1

6σ/100 right grip strength scales for males by age

SCALE SCORE	AGE																SCALE SCORE
	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
100	71	84	86	101	124	138	167	166	169	171	182	179	191	184	195	193	100
99	70	83			123	136	165	165	168	170	181	178	190	182	194	191	99
98			85	100	121	135	163	164	167	169	179	177	188	181	192	190	98
97		82	84	99	120	133	162	162	166	168	178	176	187	180	191	189	97
96	69	81		98	119	132	160	161	164	167	177	175	186	179	190	188	96
95			83	97	118	130	158	160	163	165	176	173	184	178	188	187	95
94	68	80	82	96	116	129	157	159	162	164	174	172	183	176	187	186	94
93		79		95	115	127	155	157	161	163	173	171	181	175	185	185	93
92	67		81	94	114	126	153	156	160	162	172	170	180	174	184	183	92
91		78	80	93	112	124	152	155	158	161	171	169	179	173	183	182	91
90	66	77		92	111	123	150	153	157	160	169	167	177	171	181	181	90
89		76	79		110	121	148	152	156	159	168	166	176	170	180	180	89
88	65		78	91	109	120	147	151	155	157	167	165	174	169	179	179	88
87		75		90	107	118	145	149	154	156	166	164	173	168	177	178	87
86	64	74	77	89	106	117	143	148	152	155	164	163	172	167	176	176	86
85			76	88	105	115	141	147	151	154	163	161	170	165	175	175	85
84		73		87	103	114	140	146	150	153	162	160	169	164	173	174	84
83	63	72	75	86	102	112	138	144	149	152	161	159	168	163	172	173	83
82		71		85	101	111	136	143	148	151	159	158	166	162	171	172	82
81	62		74	84	100	109	135	142	146	149	158	157	165	160	169	171	81
80		70	73	83	98	108	133	140	145	148	157	155	163	159	168	169	80
79	61	69		82	97	106	131	139	144	147	156	154	162	158	166	168	79
78			72		96	105	130	138	143	146	154	153	161	157	165	167	78
77	60	68	71	81	95	103	128	137	142	145	153	152	159	155	164	166	77
76		67		80	93	102	126	135	141	144	152	151	158	154	162	165	76
75	59	66	70	79	92	100	124	134	139	143	151	149	156	153	161	164	75
74			69	78	91	99	123	133	138	142	149	148	155	152	160	163	74
73		65		77	89	97	121	131	137	140	148	147	154	151	158	161	73
72	58	64	68	76	88	96	119	130	136	139	147	146	152	149	157	160	72
71			67	75	87	94	118	129	135	138	145	145	151	148	156	159	71
70	57	63		74	86	93	116	128	133	137	144	143	149	147	154	158	70
69		62	66	73	84	92	114	126	132	136	143	142	148	146	153	157	69
68	56		65		83	90	113	125	131	135	142	141	147	144	152	156	68
67		61		72	82	89	111	124	130	134	140	140	145	143	150	154	67
66	55	60	64	71	80	87	109	122	129	132	139	139	144	142	149	153	66
65		59		70	79	86	107	121	127	131	138	137	143	141	147	152	65
64	54		63	69	78	84	106	120	126	130	137	136	141	140	146	151	64
63		58	62	68	77	83	104	118	125	129	136	135	140	138	145	150	63
62	53	57		67	75	81	102	117	124	128	134	134	138	137	143	149	62
61			61	66	74	80	101	116	123	127	133	133	137	136	142	147	61
60		56	60	65	73	78	99	115	121	126	132	131	136	135	141	146	60
59	52	55		64	72	77	97	113	120	124	130	130	134	133	139	145	59
58		54	59		70	75	96	112	119	123	129	129	133	132	138	144	58
57	51		58	63	69	74	94	111	118	122	128	128	131	131	137	143	57
56		53		62	68	72	92	109	117	121	127	127	130	130	135	142	56
55	50	52	57	61	66	71	90	108	115	120	125	125	129	129	134	140	55
54			56	60	65	69	89	107	114	119	124	124	127	127	133	139	54
53	49	51		59	64	68	87	106	113	118	123	123	126	126	131	138	53
52		50	55	58	63	66	85	104	112	116	122	122	124	125	130	137	52
51	48	49	54	57	61	65	84	103	111	115	120	120	123	124	128	136	51

6σ/100 right grip strength scales for males by age

SCALE SCORE	AGE																SCALE SCORE
	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
100				56	60	63	82	102	109	114	119	119	122	122	127	135	100
99			53	55	59	62	80	100	108	113	118	118	120	121	126	133	99
98	47	47		54	57	60	79	99	107	112	117	117	119	120	124	132	98
97			52		56	59	77	98	106	111	115	116	118	119	123	131	97
96	46	46	51	53	55	57	75	96	105	110	114	114	116	118	122	130	96
95		45		52	54	56	74	95	103	109	113	113	115	116	120	129	95
94	45		50	51	52	54	72	94	102	107	112	112	113	115	119	128	94
93		44	49	50	51	53	70	93	101	106	110	111	112	114	118	127	93
92	44	43		49	50	51	68	91	100	105	109	110	111	113	116	125	92
91		42	48	48	49	50	67	90	99	104	108	108	109	111	115	124	91
90	43		47	47	47	48	65	89	97	103	107	107	108	110	114	123	90
89		41		46	46	47	63	87	96	102	105	106	106	109	112	122	89
88	42	40	46	45	45	45	62	86	95	101	104	105	105	108	111	121	88
87			45		43	44	60	85	94	99	103	104	104	107	109	120	87
86		39		44	42	43	58	84	93	98	102	102	102	105	108	118	86
85	41	38	44	43	41	41	57	82	91	97	100	101	101	104	107	117	85
84		37		42	40	40	55	81	90	96	99	100	99	103	105	116	84
83	40		43	41	38	38	53	80	89	95	98	99	98	102	104	115	83
82		36	42	40	37	37	51	78	88	94	97	98	97	100	103	114	82
81	39	35		39	36	35	50	77	87	93	95	96	95	99	101	113	81
80			41	38	34	34	48	76	85	91	94	95	94	98	100	111	80
79	38	34	40	37	33	32	46	74	84	90	93	94	93	97	99	110	79
78		33		36	32	31	45	73	83	89	92	93	91	96	97	109	78
77	37	32	39		31	29	43	72	82	88	90	92	90	94	96	108	77
76			38	35	29	28	41	71	81	87	89	90	88	93	95	107	76
75	36	31		34	28	26	40	69	80	86	88	89	87	92	93	106	75
74		30	37	33	27	25	38	68	78	85	86	88	86	91	92	104	74
73			36	32	26	23	36	67	77	83	85	87	84	89	90	103	73
72	35	29		31	24	22	34	65	76	82	84	86	83	88	89	102	72
71		28	35	30	23	20	33	64	75	81	83	84	81	87	88	101	71
70	34		34	29	22	19	31	63	74	80	81	83	80	86	86	100	70
69		27		28	20	17	29	62	72	79	80	82	79	85	85	99	69
68	33	26	33	27	19	16	28	60	71	78	79	81	77	83	84	97	68
67		25			18	14	26	59	70	77	78	80	76	82	82	96	67
66	32		32	26	17	13	24	58	69	76	76	78	74	81	81	95	66
65		24	31	25	15	11	23	56	68	74	75	77	73	80	80	94	65
64	31	23		24	14	10	21	55	66	73	74	76	72	78	78	93	64
63			30	23	13	8	19	54	65	72	73	75	70	77	77	92	63
62		22	29	22	11	7	17	53	64	71	71	74	69	76	76	91	62
61	30	21		21	10	5	16	51	63	70	70	72	68	75	74	89	61
60		20	28	20	9	4	14	50	62	69	69	71	66	73	73	88	60
59	29		27	19	8	2	12	49	60	68	68	70	65	72	71	87	59
58		19		18	6	1	11	47	59	66	66	69	63	71	70	86	58
57	28	18	26	17	5		9	46	58	65	65	68	62	70	69	85	57
56			25		4		7	45	57	64	64	66	61	69	67	84	56
55	27	17		16	3		6	43	56	63	63	65	60	67	66	82	55
54		16	24	15	1		4	42	54	62	61	64	58	66	65	81	54
53	26			14			2	41	53	61	60	63	56	65	63	80	53
52		15	23	13			1	40	52	60	59	62	55	64	62	79	52
51	25	14	22	12				38	51	58	58	60	54	62	61	78	51

LEFT GRIP STRENGTH OF MALES BY WEIGHT

Left hand grip strength generally increases with an increase in weight. There is little progression in left grip strength up to the interval 90–99 pounds. A marked acceleration in progression occurs from 90–130 pounds. Acceleration is slower, but steady, from 130 to 190 pounds, after which grip strengths level off. Occasional irregularities show up from 69–130 pounds. Variability is slight up through the 90–99 pounds interval. It increases from 100 to 120–129 pounds where the variability is greatest. Wide and almost equal variability occurs along with the progression range from 130 pounds through 210 and up. Males weighing less than 70 pounds have the smallest mean grip strength. 41 pounds, and those weighing 210 pounds and up have the greatest mean grip strength, 126 pounds. Mean grip strength and variability for the left hand in relation to weight is much more regular than for either hand with age. Left grip strength in relation to weight is consistently lower than right grip strength in this study, and is more regular in progression and variability.

RIGHT GRIP STRENGTH OF MALES BY WEIGHT

There is a general increase in mean right grip strength with increase in weight. Mean grip strength progression is steady with the exception of these three irregularities at 100, 110, 120, and a drop at the 200 pounds interval. These irregularities may have been caused by the difference in sample size. Variability is small up to 90 pounds and wider from 90 to 210 pounds and up. The slight irregularities in variability might well be attributed to differences in the number of cases. Males weighing less than 70 pounds have the smallest mean grip strength, 45 pounds, and those men weighing over 210 pounds and up have the greatest mean grip strength, 143 pounds. The right grip strength in relation to weight shows more irregularity in progression and variability than does the left hand grip strength. The right mean grip strength of males in relation to weight is from 3–13 pounds greater than left hand mean grip strength for every weight group.

LEFT GRIP STRENGTH OF MALES BY CLASSIFICATION INDEX I

Left hand grip strength tends to increase with an increase in Classification Index I. There is a plateau with but slight progression in grip strength from up to 594–700. From 700–980 and up there is marked and regular increase in mean grip strength, with the greatest acceleration from 700 to 875. The left grip strength seems to be approximately equally variable from Classification Index of 630 and up. The least variable is the Classification Index interval of up to 594. This interval has the least number of cases. The men with the highest Classification Index had the greatest mean grip strength, 127 pounds, and the boys with the Classification Index up to 700 had the lowest mean grip strength, 38 pounds. The left grip strength progresses more consistently with Classification Index, which includes age, height, and weight, than it does with either age or weight. Left hand grip

6σ/100 left grip strength scales for males by weight

SCALE SCORE	WEIGHT								SCALE SCORE
	Up to 69	70–9	80–9	90–9	100–9	110–9	120–9	130–9	
100	73	85	96	107	123	138	156	158	100
99		84	95	106	121	136	155	157	99
98	72		94	105	120	135	153	155	98
97	71	83	93	104	119	133	152	154	97
96		82	92	102	117	132	150	153	96
95	70	81	91	101	116	131	148	151	95
94	69		90	100	115	129	147	150	94
93		80	89	99	114	128	145	149	93
92	68	79	88	98	112	126	144	147	92
91	67	78	87	96	111	125	142	146	91
90		77	86	95	110	123	141	145	90
89	66		85	94	108	122	139	143	89
88		76	84	93	107	120	138	142	88
87	65	75	83	92	106	119	136	141	87
86	64	74	82	90	104	117	134	139	86
85			81	89	103	116	133	138	85
84	63	73	80	88	102	114	131	137	84
83	62	72	79	87	101	113	130	135	83
82		71	78	86	99	111	128	134	82
81	61		77	84	98	110	127	133	81
80	60	70	76	83	97	108	125	131	80
79		69	75	82	95	107	123	130	79
78	59	68	74	81	94	105	122	129	78
77			73	80	93	104	120	127	77
76	58	67	72	78	91	102	119	126	76
75	57	66	71	77	90	101	117	125	75
74		65	70	76	89	99	116	123	74
73	56		69	75	88	98	114	122	73
72	55	64	68	74	86	96	113	121	72
71		63	67	72	85	95	111	119	71
70	54	62	66	71	84	93	109	118	70
69	53		65	70	82	92	108	117	69
68		61	64	69	81	90	106	115	68
67	52	60	63	68	80	89	105	114	67
66	51	59	62	66	78	87	103	113	66
65			61	65	77	86	102	111	65
64	50	58	60	64	76	84	100	110	64
63		57	59	63	75	83	98	109	63
62	49	56	58	62	73	81	97	107	62
61	48		57	60	72	80	95	106	61
60		55	56	59	71	78	94	105	60
59	47	54	55	58	69	77	92	103	59
58	46	53	54	57	68	75	90	102	58
57			53	56	67	74	89	101	57
56	45	52	52	54	65	72	88	99	56
55	44	51	51	53	64	71	86	98	55
54		50	50	52	63	69	84	97	54
53	43		49	51	61	68	83	95	53
52		49	48	50	60	66	81	94	52
51	42	48	47	48	59	65	80	93	51

6σ/100 left grip strength scales for males by weight

SCALE SCORE	WEIGHT								SCALE SCORE
	Up to 69	70–9	80–9	90–9	100–9	110–9	120–9	130–9	
50	41	47	46	47	58	63	78	91	50
49		46	45	46	56	62	77	90	49
48	40			45	55	60	75	89	48
47	39	45	44	44	54	59	73	87	47
46		44	43	42	52	57	72	86	46
45	38	43	42	41	51	56	70	85	45
44	37		41	40	50	54	69	83	44
43		42	40	39	48	53	67	82	43
42	36	41	39	38	47	51	66	81	42
41		40	38	36	46	50	64	79	41
40	35		37	35	45	49	63	78	40
39	34	39	36	34	43	47	61	77	39
38		38	35	33	42	46	59	75	38
37	33	37	34	32	41	44	58	74	37
36	32		33	30	39	43	56	73	36
35		36	32	29	38	41	55	71	35
34	31	35	31	28	37	40	53	70	34
33	30	34	30	27	35	38	52	69	33
32			29	26	34	37	50	67	32
31	29	33	28	24	33	35	48	66	31
30	28	32	27	23	32	34	47	65	30
29		31	26	22	30	32	45	63	29
28	27		25	21	29	31	44	62	28
27		30	24	20	28	29	42	61	27
26	26	29	23	18	26	28	41	59	26
25	25	28	22	17	25	26	39	58	25
24			21	16	24	25	38	57	24
23	24	27	20	15	22	23	36	55	23
22	23	26	19	14	21	22	34	54	22
21		25	18	12	20	20	33	53	21
20	22		17	11	19	19	31	51	20
19	21	24	16	10	17	17	30	50	19
18		23	15	9	16	16	28	49	18
17	20	22	14	8	15	14	27	47	17
16			13	6	13	13	25	46	16
15	19	21	12	5	12	11	23	45	15
14	18	20	11	4	11	10	22	43	14
13		19	10	3	9	8	20	42	13
12	17		9	2	8	7	19	41	12
11	16	18	8		7	5	17	39	11
10		17	7		5	4	16	38	10
9	15	16	6		4	2	14	37	9
8	14	15	5		3	1	13	35	8
7			4		2		11	34	7
6	13	14	3				9	33	6
5		13	2				8	31	5
4	12	12	1				6	30	4
3	11						5	29	3
2		11					3	27	2
1	10	10					2	26	1

6σ/100 left grip strength scales for males by weight

SCALE SCORE	WEIGHT								SCALE SCORE
	140–9	150–9	160–9	170–9	180–9	190–9	200–9	210 up	
100	158	164	174	169	182	179	189	180	100
99	157	163	173	168	181	178	188	179	99
98	155	162	172	167	170	177	186	178	98
97	154	160	170	166	178	176	185	177	97
96	153	159	169	164	177	174	184	176	96
95	152	158	168	163	176	173	183	175	95
94	151	157	167	162	174	172	181	174	94
93	149	155	165	161	173	171	180	173	93
92	148	154	164	160	172	170	179	171	92
91	147	153	163	159	171	169	178	170	91
90	146	152	161	158	169	168	176	169	90
89	145	150	160	157	168	167	175	168	89
88	144	149	159	155	167	166	174	167	88
87	142	148	157	154	165	165	173	166	87
86	141	147	156	153	164	163	171	165	86
85	140	146	155	152	163	162	170	164	85
84	139	144	153	151	162	161	169	163	84
83	138	143	152	150	150	160	167	162	83
82	136	142	151	149	159	159	166	161	82
81	135	141	149	148	158	158	165	160	81
80	134	139	148	146	156	157	164	159	80
79	133	138	147	145	155	156	162	157	79
78	132	137	145	144	154	155	161	156	78
77	130	136	144	143	152	154	160	155	77
76	129	134	143	142	151	152	159	154	76
75	128	133	141	141	150	151	157	153	75
74	127	132	140	140	149	150	156	152	74
73	126	131	139	139	147	149	155	151	73
72	125	129	137	137	146	148	153	150	72
71	123	128	136	136	145	147	152	149	71
70	122	127	135	135	143	146	151	148	70
69	121	126	134	134	142	145	150	147	69
68	120	124	132	133	141	144	148	146	68
67	119	123	131	132	140	142	147	145	67
66	117	122	130	131	138	141	146	143	66
65	116	121	128	130	137	140	145	142	65
64	115	119	127	128	136	139	143	141	64
63	114	118	126	127	134	138	142	140	63
62	113	117	124	126	133	137	141	139	62
61	111	116	123	125	132	136	140	138	61
60	110	114	122	124	131	135	138	137	60
59	109	113	120	123	129	134	137	136	59
58	108	112	119	122	128	133	136	135	58
57	107	111	118	120	127	131	134	134	57
56	106	109	116	119	125	130	133	133	56
55	104	108	115	118	124	129	132	132	55
54	103	107	114	117	123	128	131	131	54
53	102	106	112	116	121	127	129	129	53
52	101	104	111	115	120	126	128	128	52
51	100	103	110	114	119	125	127	127	51

6σ/100 left grip strength scales for males by weight

SCALE SCORE	WEIGHT								SCALE SCORE
	140–9	150–9	160–9	170–9	180–9	190–9	200–9	210 up	
50	98	102	108	113	118	124	126	126	50
49	97	101	107	111	116	123	124	125	49
48	96	99	106	110	115	122	123	124	48
47	95	98	104	109	114	120	122	123	47
46	94	97	103	108	112	119	120	122	46
45	92	96	102	107	111	118	119	121	45
44	91	94	101	106	110	117	118	120	44
43	90	93	99	105	109	116	117	119	43
42	89	92	98	104	107	115	115	118	42
41	88	91	97	102	106	114	114	117	41
40	87	89	95	101	105	113	113	115	40
39	85	88	94	100	103	112	112	114	39
38	84	87	93	99	102	111	110	113	38
37	83	86	91	98	101	109	109	112	37
36	82	85	90	97	99	108	108	111	36
35	81	83	89	96	98	107	107	110	35
34	79	82	87	95	97	106	105	109	34
33	78	81	86	93	96	105	104	108	33
32	77	80	85	92	94	104	103	107	32
31	76	78	83	91	93	103	101	106	31
30	75	77	82	90	92	102	100	105	30
29	73	76	81	89	90	101	99	104	29
28	72	75	79	88	89	100	98	103	28
27	71	73	78	87	88	98	96	101	27
26	70	72	77	86	87	97	95	100	26
25	69	71	75	84	85	96	94	99	25
24	68	79	74	73	84	95	93	98	24
23	66	68	73	82	83	94	91	97	23
22	65	67	71	81	81	93	90	96	22
21	64	66	70	80	80	92	89	95	21
20	63	65	69	79	79	91	88	94	20
19	62	63	68	78	78	90	86	93	19
18	60	62	66	76	76	89	85	92	18
17	59	61	65	75	75	87	84	91	17
16	58	60	64	74	74	86	82	90	16
15	57	58	62	73	72	85	81	88	15
14	56	57	61	72	71	84	80	87	14
13	54	56	60	71	70	83	79	86	13
12	53	55	58	70	68	82	77	85	12
11	52	53	57	69	67	81	76	84	11
10	51	52	56	67	66	80	75	83	10
9	50	51	54	66	65	79	74	82	9
8	48	50	53	65	63	78	72	81	8
7	47	48	52	64	62	76	71	80	7
6	46	47	50	63	61	75	70	79	6
5	45	46	49	62	59	74	68	78	5
4	44	45	48	61	58	73	67	77	4
3	43	43	46	60	57	72	66	76	3
2	41	42	45	58	56	71	65	74	2
1	40	41	44	57	54	70	63	73	1

6σ/100 right grip strength scales for males by weight

SCALE SCORE	WEIGHT								SCALE SCORE
	Up to 69	70–9	80–9	90–9	100–9	110–9	120–9	130–9	
100	82	87	100	120	132	133	167	168	100
99		86	99	119	131	132	165	167	99
98	81		98	117	130	131	164	165	98
97	80	85	97	116	128	129	162	164	97
96	79	84	96	115	127	128	160	163	96
95			95	114	126	127	159	161	95
94	78	83	94	112	124	125	157	160	94
93	77	82	93	111	123	124	156	158	93
92			92	110	122	123	154	157	92
91	76	81	91	108	121	121	152	156	91
90	75	80		107	119	120	151	154	90
89	74		90	106	118	119	149	153	89
88		79	89	105	117	117	148	152	88
87	73	78	88	103	115	116	146	150	87
86	72		87	102	114	115	145	149	86
85	71	77	86	101	113	113	143	147	85
84		76	85	99	111	112	141	146	84
83	70		84	98	110	111	140	145	83
82	69	75	83	97	109	109	138	143	82
81	68	74	82	95	107	108	137	142	81
80		73	81	94	106	107	135	141	80
79	67		80	93	105	105	133	139	79
78	66	72	79	92	104	104	132	138	78
77	65	71	78	90	102	103	130	136	77
76			77	89	101	101	129	135	76
75	64	70	76	88	100	100	127	134	75
74	63	69	75	86	98	99	126	132	74
73	62			85	97	97	124	131	73
72		68	74	84	96	96	122	130	72
71	61	67	73	82	94	95	121	128	71
70	60		72	81	93	93	119	127	70
69	59	66	71	80	92	92	118	125	69
68		65	70	79	90	91	116	124	68
67	58		69	77	89	89	114	123	67
66	57	64	68	76	88	88	113	121	66
65	56	63	67	75	86	87	111	120	65
64			66	73	85	85	110	119	64
63	55	62	65	72	84	84	108	117	63
62	54	61	64	71	83	83	107	116	62
61			63	70	81	81	105	114	61
60	53	60	62	68	80	80	103	113	60
59	52	59	61	67	79	79	102	112	59
58	51		60	66	77	77	100	110	58
57		58		64	76	76	99	109	57
56	50	57	59	63	75	75	97	108	56
55	49		58	62	73	73	95	106	55
54	48	56	57	60	72	71	94	105	54
53		55	56	59	71	70	92	103	53
52	47		55	58	69	69	91	102	52
51	46	54	54	57	68	68	89	101	51

6σ/100 right grip strength scales for males by weight

SCALE SCORE	WEIGHT								SCALE SCORE
	Up to 69	70–9	80–9	90–9	100–9	110–9	120–9	130–9	
50	45	53	53	55	67	66	88	99	50
49		52	52	54	65	65	86	98	49
48	44		51	53	64	64	84	97	48
47	43	51	50	52	63	62	83	95	47
46	42	50	49	50	62	61	81	94	46
45			48	49	60	60	80	92	45
44	41	49	47	47	59	58	78	91	44
43	40	48	46	46	58	57	76	90	43
42	39		45	45	56	56	75	88	42
41		47		44	55	54	73	87	41
40	38	46	44	43	54	53	72	85	40
39	37		43	41	52	52	70	84	39
38	36	45	42	40	51	50	68	83	38
37		44	41	39	50	49	67	81	37
36	35		40	37	48	48	65	80	36
35	34	43	39	36	47	46	64	79	35
34	33	42	38	35	46	45	62	77	34
33			37	33	45	44	61	76	33
32	32	41	36	32	43	42	59	74	32
31	31	40	35	31	42	41	57	73	31
30		39	34	30	41	40	56	72	30
29	30		33	28	39	38	54	70	29
28	29	38	32	27	38	37	53	69	28
27	28		31	26	37	36	51	68	27
26		37	30	24	35	34	49	66	26
25	27	36	29	23	34	33	48	65	25
24	26			22	33	32	46	63	24
23	25	35	28	20	31	30	45	62	23
22		34	27	19	30	29	43	61	22
21	24	33	26	18	29	28	42	59	21
20	23		25	17	27	26	40	58	20
19	22	32	24	15	26	25	38	57	19
18		31	23	14	25	24	37	55	18
17	21		22	13	24	22	35	54	17
16	20	30	21	11	22	21	34	52	16
15	19	29	20	10	21	20	32	51	15
14			19	9	20	18	30	50	14
13	18	28	18	8	18	17	29	48	13
12	17	27	17	6	17	16	27	47	12
11	16		16	5	16	14	26	46	11
10		26	15	4	14	13	24	44	10
9	15	25	14	2	13	12	23	43	9
8	14			1	12	10	21	41	8
7	13	24	13		10	9	19	40	7
6		23	12		9	8	18	39	6
5	12		11		8	6	16	37	5
4	11	22	10		7	5	15	36	4
3	10	21	9		5	4	13	35	3
2			8		4	2	11	33	2
1	9	20	7		3	1	10	32	1

6σ/100 right grip strength scales for males by weight

SCALE SCORE	WEIGHT								SCALE SCORE
	140-9	150-9	160-9	170-9	180-9	190-9	200-9	210 up	
100	165	177	187	183	199	187	188	200	100
99	164	176	185	182	197	186	187	199	99
98	163	174	184	181	196	185	196	198	98
97	162	173	182	180	194	184	185	197	97
96	160	172	181	178	193	183	184	196	96
95	159	170	180	177	192	182	183	194	95
94	158	169	178	176	190	181	182	193	94
93	157	168	177	175	189	180	181	192	93
92	156	167	176	174	187	179	179	191	92
91	155	165	174	173	186	178	178	190	91
90	153	164	173	171	184	177	177	189	90
89	152	163	172	170	183	176	176	188	89
88	151	161	170	169	182	175	175	186	88
87	150	160	169	168	180	174	174	185	87
86	149	159	168	166	179	173	173	184	86
85	148	158	166	165	177	172	172	183	85
84	146	156	165	164	176	171	171	182	84
83	145	155	164	163	174	170	170	181	83
82	144	154	162	162	173	169	168	180	82
81	143	152	161	161	172	168	167	179	81
80	142	151	160	160	170	167	166	177	80
79	141	150	158	159	169	166	165	176	79
78	139	149	157	158	167	165	164	175	78
77	138	147	155	156	166	164	163	174	77
76	137	146	154	155	165	163	162	173	76
75	136	145	153	154	163	162	161	172	75
74	135	143	151	153	162	161	160	171	74
73	134	142	150	152	160	160	158	169	73
72	132	141	149	151	159	159	157	168	72
71	131	139	147	150	157	158	156	157	71
70	130	138	146	148	156	157	155	166	70
69	129	137	145	167	155	156	154	165	69
68	128	136	143	146	153	155	153	164	68
67	127	134	142	145	152	154	152	163	67
66	126	133	141	144	150	153	151	161	66
65	124	132	139	143	149	152	150	160	65
64	123	130	138	141	148	151	148	159	64
63	122	129	137	140	146	150	147	158	63
62	121	128	135	139	145	149	146	157	62
61	120	127	134	138	143	148	145	156	61
60	119	125	133	137	142	147	144	155	60
59	117	124	131	136	140	146	143	154	59
58	116	123	130	135	139	145	142	152	58
57	115	121	128	133	138	144	141	151	57
56	114	120	127	132	136	143	140	150	56
55	113	119	126	131	135	142	139	149	55
54	112	118	124	130	133	141	137	148	54
53	110	116	123	129	132	140	136	147	53
52	109	115	122	128	131	139	135	146	52
51	108	114	120	126	129	138	134	144	51

6σ/100 right grip strength scales for males by weight

SCALE SCORE	WEIGHT								SCALE SCORE
	140-9	150-9	160-9	170-9	180-9	190-9	200-9	210 up	
50	107	112	119	125	128	137	133	143	50
49	106	111	118	124	126	136	132	142	49
48	105	110	116	123	125	135	131	141	48
47	103	109	115	122	123	134	130	140	47
46	102	107	114	120	122	133	129	139	46
45	101	106	112	119	121	132	127	138	45
44	100	105	111	118	119	131	126	136	44
43	99	103	110	117	118	130	125	135	43
42	98	102	108	116	116	129	124	134	42
41	96	101	107	115	115	128	123	133	41
40	95	100	106	113	113	127	122	132	40
39	94	98	104	112	112	126	121	131	39
38	93	97	103	111	111	125	120	130	38
37	92	96	101	110	109	124	119	129	37
36	91	94	100	109	108	123	118	127	36
35	89	93	99	108	106	122	116	126	35
34	88	92	97	107	105	121	115	125	34
33	87	91	96	105	104	120	114	124	33
32	86	89	95	104	102	119	113	123	32
31	85	88	93	103	101	118	112	122	31
30	84	87	92	102	99	117	111	121	30
29	82	85	91	101	98	116	110	119	29
28	81	84	89	100	96	115	109	118	28
27	80	83	88	98	95	114	108	117	27
26	79	82	87	97	94	113	106	116	26
25	78	80	85	96	92	112	105	115	25
24	77	79	84	95	91	111	104	114	24
23	75	78	83	94	89	110	103	113	23
22	74	76	81	93	88	109	102	111	22
21	73	75	80	92	87	108	101	110	21
20	72	74	79	90	85	107	100	109	20
19	71	73	77	89	84	106	99	108	19
18	70	71	76	88	82	105	98	107	18
17	68	70	74	87	81	104	96	106	17
16	67	69	73	86	79	103	95	105	16
15	66	67	72	85	78	102	94	103	15
14	65	66	70	83	77	101	93	102	14
13	64	65	69	82	75	100	92	101	13
12	63	64	68	81	74	99	91	100	12
11	61	12	66	80	72	98	90	99	11
10	60	61	65	79	71	97	89	98	10
9	59	60	64	78	69	96	88	97	9
8	58	58	62	76	68	95	87	96	8
7	57	57	61	75	67	94	85	94	7
6	56	56	60	74	65	93	84	93	6
5	55	55	58	73	64	92	83	92	5
4	53	53	57	72	62	91	82	91	4
3	52	52	56	71	61	90	81	90	3
2	51	51	54	70	60	89	80	89	2
1	50	49	53	68	58	88	79	88	1

6σ/100 left grip strength scales for males by C. I.

SCALE SCORE	CLASSIFICATION INDEX							SCALE SCORE
	Up to 594	595–629	630–664	665–699	700–734	735–769	770–804	
100		83	100	95	102	121	129	100
99	58	82	99	94	101	120	128	99
98			97	93	100	118	126	98
97		81	96	92	98	117	125	97
96	57	80	95	91	97	116	123	96
95		79	94	90	96	114	122	95
94	56	78	93	89	95	113	121	94
93			91	88	94	112	119	93
92		77	90	87	93	110	118	92
91	55	76	89	85	91	109	116	91
90		75	88	84	90	108	115	90
89	54	74	86	83	89	106	113	89
88		73	85	82	88	105	112	88
87			84	81	87	104	111	87
86	53	72	83	80	85	102	109	86
85		71	81	79	84	101	108	85
84	52	70	80	78	83	100	106	84
83		69	79	77	82	98	105	83
82		68	78	76	81	97	104	82
81	51		76	75	80	96	102	81
80		67	75	73	78	94	101	80
79	50	66	74	72	77	93	99	79
78		65	73	71	76	92	98	78
77		64	71	70	75	90	97	77
76	49	63	70	69	74	89	95	76
75			69	68	72	88	94	75
74	48	62	68	67	71	86	92	74
73		61	66	66	70	85	91	73
72	47	60	65	65	69	84	90	72
71		59	64	64	68	82	88	71
70		58	63	63	67	81	87	70
69	46		61	62	65	80	85	69
68		57	60	60	64	78	84	68
67	45	56	59	59	63	77	82	67
66		55	58	58	62	76	81	66
65		54	56	57	61	74	80	65
64	44	53	55	56	59	73	78	64
63			54	55	58	72	77	63
62	43	52	53	54	57	70	75	62
61		51	51	53	56	69	74	61
60		50	50	52	55	68	73	60
59	42	49	49	51	54	66	71	59
58		48	48	49	52	65	70	58
57	41		46	48	51	64	68	57
56		47	45	47	50	62	67	56
55		46	44	46	49	61	66	55
54	40	45	43	45	48	59	64	54
53		44	41	44	46	58	63	53
52	39	43	40	43	45	57	61	52
51			39	42	44	55	60	51

6σ/100 left grip strength scales for males by C. I.

SCALE SCORE	CLASSIFICATION INDEX							SCALE SCORE
	Up to 594	595–629	630–664	665–699	700–734	735–769	770–804	
50		42	38	41	43	54	58	50
49	38	41	36	40	42	53	57	49
48		40	35	39	41	51	56	48
47	37	39	34	38	39	50	54	47
46			33	36	38	49	53	46
45	36	38	32	35	37	47	51	45
44		37	30	34	36	46	50	44
43		36	29	33	35	45	49	43
42	35	35	28	32	34	43	47	42
41		34	27	31	32	42	46	41
40	34		25	30	31	41	44	40
39		33	24	29	30	39	43	39
38		32	23	28	29	38	42	38
37	33	31	22	27	28	37	40	37
36		30	20	26	26	35	39	36
35	32	29	19	24	25	34	37	35
34			18	23	24	33	36	34
33		28	17	22	23	31	35	33
32	31	27	15	21	22	30	33	32
31		26	14	20	21	29	32	31
30	30	25	13	19	19	27	30	30
29		24	12	18	18	26	29	29
28			10	17	17	25	27	28
27	29	23	9	16	16	23	26	27
26		22	8	15	15	22	25	26
25	28	21	7	14	13	21	23	25
24		20	5	12	12	19	22	24
23	27	19	4	11	11	18	20	23
22			3	10	10	17	19	22
21		18	2	9	9	15	18	21
20	26	17	1	8	8	14	16	20
19		16		7	6	13	15	19
18	25	15		6	5	11	13	18
17				5	4	10	12	17
16		14		4	3	9	11	16
15	24	13		3	2	7	9	15
14		12		2		6	8	14
13	23	11		1		5	6	13
12		10				3	5	12
11		9				2	3	11
10	22					1	2	10
9		8					1	9
8	21	7						8
7		6						7
6		5						6
5	20							5
4		4						4
3	19	3						3
2		2						2
1		1						1

6σ/100 left grip strength scales for males by C. I.

SCALE SCORE	CLASSIFICATION INDEX						SCALE SCORE
	805–839	840–874	875–909	910–944	945–979	980 and up	
100	145	156	162	169	181	191	100
99	143	155	161	168	180	190	99
98	142	154	159	167	179	188	98
97	140	152	158	166	177	187	97
96	139	151	157	164	176	186	96
95	138	150	156	163	175	185	95
94	136	148	155	162	174	183	94
93	135	147	154	161	173	182	93
92	133	146	153	160	171	181	92
91	132	144	151	159	170	179	91
90	131	143	150	157	169	178	90
89	129	142	149	156	168	177	89
88	128	141	148	155	166	176	88
87	126	139	147	154	165	174	87
86	125	138	146	153	164	173	86
85	124	137	145	152	163	172	85
84	122	135	143	151	162	170	84
83	121	134	142	149	160	169	83
82	119	133	141	148	159	168	82
81	118	131	140	147	158	167	81
80	116	130	139	146	157	165	80
79	115	129	138	145	156	164	79
78	114	127	136	144	154	163	78
77	112	126	135	143	153	161	77
76	111	125	134	141	152	160	76
75	109	124	133	140	151	159	75
74	108	122	132	139	150	158	74
73	107	121	131	138	148	156	73
72	105	120	130	137	147	155	72
71	104	118	128	136	146	154	71
70	102	117	127	134	145	152	70
69	101	116	126	133	143	151	69
68	100	114	125	132	142	150	68
67	98	113	124	131	141	148	67
66	97	112	123	130	140	147	66
65	95	110	122	129	139	146	65
64	94	109	120	128	137	145	64
63	93	108	119	126	136	143	63
62	91	107	118	125	135	142	62
61	90	105	117	124	134	141	61
60	88	104	116	123	133	139	60
59	87	103	115	122	131	138	59
58	85	101	113	121	130	137	58
57	84	100	112	120	129	136	57
56	83	99	111	118	128	134	56
55	81	97	110	117	127	133	55
54	80	96	109	116	125	132	54
53	78	95	108	115	124	130	53
52	77	93	107	114	123	129	52
51	76	92	105	113	122	128	51

6σ/100 left grip strength scales for males by C. I.

SCALE SCORE	CLASSIFICATION INDEX						SCALE SCORE
	805–839	840–874	875–909	910–944	945–979	980 and up	
50	74	91	104	111	120	127	50
49	73	89	103	110	119	125	49
48	71	88	102	109	118	124	48
47	70	87	101	108	117	123	47
46	69	86	100	107	116	121	46
45	67	84	99	106	114	120	45
44	66	83	97	104	113	119	44
43	64	82	96	103	112	118	43
42	63	80	95	102	111	116	42
41	62	79	94	101	110	115	41
40	60	78	93	100	108	114	40
39	59	76	92	99	107	112	39
38	57	75	90	98	106	111	38
37	56	74	89	97	105	110	37
36	54	72	88	95	104	109	36
35	53	71	87	94	102	107	35
34	52	70	86	93	101	106	34
33	50	69	85	92	100	105	33
32	49	67	84	91	99	103	32
31	47	66	82	90	98	102	31
30	46	65	81	88	96	101	30
29	45	63	80	87	95	99	29
28	43	62	79	86	94	98	28
27	42	61	78	85	93	97	27
26	40	59	77	84	91	96	26
25	39	58	76	83	90	94	25
24	38	56	74	82	89	93	24
23	36	55	73	80	88	92	23
22	35	54	72	79	87	90	22
21	33	53	71	78	85	89	21
20	32	51	70	77	84	88	20
19	30	50	69	76	83	87	19
18	29	49	67	75	82	85	18
17	28	48	66	74	81	84	17
16	26	46	65	72	79	83	16
15	25	45	64	71	78	81	15
14	23	44	63	70	77	80	14
13	22	42	62	69	76	79	13
12	21	41	61	68	75	78	12
11	19	40	59	67	73	76	11
10	18	38	58	65	72	75	10
9	16	37	57	64	71	74	9
8	15	36	56	63	70	72	8
7	14	34	55	62	68	71	7
6	12	33	54	61	67	70	6
5	11	32	53	60	66	69	5
4	9	31	51	59	65	67	4
3	8	29	50	57	64	66	3
2	7	28	49	56	62	65	2
1	5	27	48	55	61	63	1

6σ/100 right grip strength scales for males by C. I.

SCALE SCORE	CLASSIFICATION INDEX							SCALE SCORE
	Up to 594	595–629	630–664	665–699	700–734	735–769	770–804	
100	69	87	98	103	114	125	136	100
99		86	97	102	113	124	135	99
98	68	85	96	101	111	123	134	98
97		84	95	100	110	121	132	97
96	67	83	94	98	109	120	131	96
95			93	97	107	119	129	95
94	66	82	92	96	106	117	128	94
93		81	91	95	105	116	127	93
92	65	80	90	94	104	115	125	92
91		79	89	93	102	113	124	91
90	64		88	92	101	112	123	90
89		78	87	91	100	111	121	89
88	63	77	86	90	99	109	120	88
87		76	85	89	97	108	118	87
86	62	75	84	87	96	107	117	86
85		74	83	86	95	105	116	85
84	61		82	85	93	104	114	84
83		73	81	84	92	103	113	83
82	60	72	80	83	91	101	112	82
81		71	78	82	90	100	110	81
80	59	70	77	81	88	99	109	80
79		69	76	80	87	97	107	79
78	58		75	79	86	96	106	78
77		68	74	78	85	94	105	77
76	57	67	73	76	83	93	103	76
75		66	72	75	82	92	102	75
74	56	65	71	74	81	90	100	74
73			70	73	80	89	99	73
72	55	64	69	72	78	88	98	72
71		63	68	71	77	86	96	71
70	54	62	67	70	76	85	95	70
69		61	66	69	74	84	93	69
68	53	60	65	68	73	82	92	68
67			64	67	72	81	91	67
66	52	59	63	65	71	80	89	66
65		58	62	64	69	78	88	65
64	51	57	61	63	68	77	87	64
63		56	60	62	67	76	85	63
62	50	55	59	61	66	74	84	62
61			57	60	64	73	83	61
60	49	54	56	59	63	72	81	60
59		53	55	58	62	70	80	59
58	48	52	54	57	60	69	78	58
57		51	53	56	59	68	77	57
56	47		52	55	58	66	76	56
55		50	51	53	57	65	74	55
54	46	49	50	52	55	64	73	54
53		48	49	51	54	62	72	53
52	45	47	48	50	53	61	70	52
51		46	47	49	52	60	69	51

6σ/100 right grip strength scales for males by C. I.

SCALE SCORE	CLASSIFICATION INDEX							SCALE SCORE
	Up to 594	595–629	630–664	665–699	700–734	735–769	770–804	
50	44		46	48	50	58	68	50
49		45	45	47	49	57	66	49
48	43	44	44	46	48	56	65	48
47		43	43	45	47	54	63	47
46	42	42	42	44	45	53	62	46
45			41	42	44	52	61	45
44	41	41	40	41	43	50	59	44
43		40	39	30	41	49	58	43
42	40	39	38	39	40	48	56	42
41		38	36	38	39	46	55	41
40	39	37	35	37	38	45	54	40
39			34	36	36	43	52	39
38	38	36	33	35	35	42	51	38
37		35	32	34	34	41	50	37
36	37	34	31	33	33	39	48	36
35		33	30	31	31	38	47	35
34	36		29	30	30	37	45	34
33		32	28	29	29	35	44	33
32	35	31	27	28	27	34	43	32
31		30	26	27	26	33	41	31
30	34	29	25	26	25	31	40	30
29		28	24	25	24	30	39	29
28	33		23	24	22	29	37	28
27		27	22	23	21	27	36	27
26	32	26	21	22	20	26	34	26
25		25	20	20	19	25	33	25
24	31	24	19	19	17	23	32	24
23		23	18	18	16	22	30	23
22	30		17	17	15	21	29	22
21		22	15	16	13	19	28	21
20	29	21	14	15	12	18	26	20
19		20	13	14	11	17	25	19
18	28	19	12	13	10	15	23	18
17			11	12	8	14	22	17
16	27	18	10	11	7	13	21	16
15		17	9	10	6	11	19	15
14	26	16	8	8	5	10	18	14
13		15	7	7	3	9	17	13
12	25	14	6	6	2	7	15	12
11			5	5	1	6	14	11
10	24	13	4	4		5	12	10
9		12	3	3		3	11	9
8	23	11	2	2		2	10	8
7		10	1	1		1	8	7
6	22						7	6
5		9					6	5
4	21	8					4	4
3		7					3	3
2	20	6					1	2
1		5						1

6σ/100 right grip strength scales for males by C. I.

SCALE SCORE	CLASSIFICATION INDEX						SCALE SCORE
	805–839	840–874	875–909	910–944	945–979	980 and up	
100	151	164	167	180	194	210	100
99	149	162	166	178	192	208	99
98	148	161	165	177	191	207	98
97	147	160	164	176	190	206	97
96	145	159	163	175	189	204	96
95	144	157	162	174	187	203	95
94	142	156	161	173	186	202	94
93	141	155	159	171	185	200	93
92	140	154	158	170	184	199	92
91	138	152	157	169	182	198	91
90	137	151	156	168	181	197	90
89	135	150	155	167	180	195	89
88	134	148	154	166	179	194	88
87	133	147	153	164	177	193	87
86	131	146	152	163	176	191	86
85	130	145	150	162	175	190	85
84	128	143	149	161	174	189	84
83	127	142	148	160	172	187	83
82	126	141	147	159	171	186	82
81	124	140	146	157	170	185	81
80	123	138	145	156	169	183	80
79	121	137	144	155	167	182	79
78	120	136	143	154	166	181	78
77	119	134	141	153	165	179	77
76	117	133	140	151	164	178	76
75	116	132	139	150	162	177	75
74	114	131	138	149	161	175	74
73	113	129	137	148	160	174	73
72	112	128	136	147	159	173	72
71	110	127	135	146	157	171	71
70	109	126	134	144	156	170	70
69	107	124	133	143	155	169	69
68	106	123	131	142	153	167	68
67	105	122	130	141	152	166	67
66	103	120	129	140	151	165	66
65	102	119	128	138	150	163	65
64	100	118	127	137	149	162	64
63	99	117	126	136	147	161	63
62	98	115	125	135	146	159	62
61	96	114	124	134	145	158	61
60	95	113	122	133	144	157	60
59	93	112	121	132	142	155	59
58	92	110	120	130	141	154	58
57	91	109	119	129	140	153	57
56	89	108	118	128	139	151	56
55	88	106	117	127	137	150	55
54	86	105	116	126	136	149	54
53	85	104	115	125	135	147	53
52	84	103	113	123	134	146	52
51	82	101	112	122	132	145	51

6σ/100 right grip strength scales for males by C. I.

SCALE SCORE	CLASSIFICATION INDEX						SCALE SCORE
	805–839	840–874	875–909	910–944	945–979	980 and up	
50	81	100	111	121	131	143	50
49	80	99	110	120	130	142	49
48	78	98	109	119	129	141	48
47	77	96	108	118	127	139	47
46	75	95	107	116	126	138	46
45	74	94	106	115	125	137	45
44	73	92	104	114	124	135	44
43	71	91	103	113	122	134	43
42	70	90	102	112	121	133	42
41	68	89	101	111	120	131	41
40	67	87	100	109	119	130	40
39	66	86	99	108	117	129	39
38	64	85	98	107	116	127	38
37	63	84	97	106	115	126	37
36	61	82	96	105	114	125	36
35	60	81	94	104	112	123	35
34	59	80	93	102	111	122	34
33	57	78	92	101	110	121	33
32	56	77	91	100	109	119	32
31	54	76	90	99	107	118	31
30	53	75	89	98	106	117	30
29	52	73	88	97	105	115	29
28	50	72	87	95	104	114	28
27	49	71	85	94	102	113	27
26	47	70	84	93	101	111	26
25	46	68	83	92	100	110	25
24	45	67	82	91	99	109	24
23	43	66	81	89	97	107	23
22	42	64	80	88	96	106	22
21	40	63	79	87	95	105	21
20	39	62	78	86	94	103	20
19	38	61	76	85	92	102	19
18	36	59	75	84	91	101	18
17	35	58	74	82	90	99	17
16	33	57	73	81	89	98	16
15	32	56	72	80	87	97	15
14	31	54	71	79	86	95	14
13	29	53	70	78	85	94	13
12	28	52	69	77	84	93	12
11	26	50	67	75	82	91	11
10	25	49	66	74	81	90	10
9	24	48	65	73	80	89	9
8	22	47	64	72	79	87	8
7	21	45	63	71	77	86	7
6	19	44	62	69	76	85	6
5	18	43	61	68	75	83	5
4	17	42	60	67	73	82	4
3	15	40	59	66	72	81	3
2	14	39	57	65	71	79	2
1	12	38	56	64	70	78	1

strength is not as consistent as the right hand grip strength as it progresses through the Classification Index intervals.

RIGHT GRIP STRENGTH OF MALES BY CLASSIFICATION INDEX I

Right hand mean grip strength tends to increase with an increase in Classification Index I. There is slight progression in mean grip strength from up to 594 through the interval 700–734. Beyond this last interval there is marked and regular acceleration on through 980 and up. The lowest mean grip strength, 44 pounds, is in the lowest Classification Index group, up to 594, and the greatest mean grip strength, 143 pounds, is in the highest interval, 980 and up. Right hand grip strength variability is regular through the complete Classification Index range from up to 594 through 980 and up. Variability is small from up to 594 to 665, after which it increases a little and remains fairly equal throughout the range 665 through 980 and up. The least variable is the Classification Index group of up to 594. By comparison the variability in grip strength from Classification Index 700–734 through 980 and up is the smoothest of all the profiles.

Summary and Conclusions

1. Age, weight, and Classification Index I are all factors influencing grip strength.
2. Right hand mean grip strength is consistently greater than left hand mean grip strength in relation to age, weight, and Classification Index I. This might indicate that the right hand is always stronger, however the true handedness of the sample is unknown.
3. Right hand and left hand grip strengths are more consistent in relation to Classification Index I, which includes age, height, and weight, than to either age or weight alone. It would seem therefore that Classification Index I is more valuable in determining grip strength than either age or weight. Right hand grip strength in relation to Classification Index I is the most consistent single measure of grip strength studied here.
4. Right and left hand grip strengths are less consistent in relation to age than to weight or Classification Index I. Age, then, according to this study is not as valuable a factor in determining grip strength as weight or Classification Index I.
5. The smallest mean grip strengths are found in the youngest age group, the lowest weight group, and the lowest Classification Index I group.
6. The greatest mean grip strengths are found in the oldest age group, the heaviest weight group, and the highest Classification Index I group.
7. Each of the profile curves is similar in shape, starting with slow progression of mean grip strength, increased acceleration and finally less rapid acceleration.
8. Each of the profile curves is similar in variability, starting with slight variability followed by a period of increased variability, then followed by fairly equal variability throughout the remainder of the curve.

Relationship Between Teammate Status and Measures of Skill in Volleyball

RUTH E. FULTON
University of California at Los Angeles

IN A RECENT study, Breck (1) suggested that sociometric techniques are applicable in physical education classes. This suggestion was based on the indicated reliability and ease of administration. The extent to which these measures can contribute to research and teaching in the field rests on the clarification of the factors which influence students' choices of teammates.

It has been demonstrated that teammate status has a small but consistent relationship with friendship status. Using 586 subjects, Breck found mean correlations of .43 ± .02 and .57 ± .02 between friendship scores[1] and teammate scores in two administrations of the tests. Frost (2) obtained a correlation of 0.40 ± .03 between friendship scores and teammate scores for both administrations of her test.

A question which arises is the extent to which teammate status is related to skill. Frost (2) initiated the study in this area by correlating the scores of the French (3) volleying test and measures of teammate status. The correlations obtained by Frost were .51 ± .02 on the first administration of the tests and .50 ± .02 on the administration of the test given six weeks later. The correlations between friendship scores and volleying scores were not significantly different from zero.

From these results it would seem that student choices of teammates are related somewhat to 1) friendship, as measured by stated choices of friends, and 2) skill, as measured by the French volleying test.

Statement of Problem

The purpose of this study was to extend the investigation of the relationship between teammate status and skill in volleyball classes so as to include additional measures of skill. The measures of skill used were 1) teacher judgment, 2) French volleying test, and 3) French serving test.

Importance of the Study

The validity of the French volleying test is low enough (.72) to make Frost's study inconclusive regarding the relationship between skill and teammate status. Since the volleying test was validated by correlating the scores on the test with teacher judgments, a more direct approach to

[1] See Breck (1) for the explanation of these "scores."

the relationship between teammate status and skill would be to use teacher judgment as the standard of skill.

Method of Procedure

Two volleyball classes in the women's division of physical education at the University of California at Los Angeles were chosen for the study. The enrollment was 37 in one class and 31 in the other. Sixty-four students were present for all of the tests and constituted the subjects for the study. The experiment was conducted during the last four weeks of the semester.

The students were requested to list the five classmates they most preferred to have as teammates. A teammate status score was the number of times an individual was chosen as a teammate.

The instructor of the class and the author made independent judgment ratings of the skill of the class members on a ten point scale. The volleying test and the serving test were administered in accordance with the procedure recommended by French.

TABLE 1

Intercorrelations of judgment ratings, teammate status scores, volleying scores, and serving scores

	JUDGMENT RATING	TEAMMATE STATUS SCORES	VOLLEYING SCORES
Serving Scores	.52 ± .06	.23* ± .08	.35 ± .07
Volleying Scores	.71 ± .04	.54* ± .06	
Teammate Status Scores	.71* ± .04		

* Rank order correlations.

Results

Reliability. The split half method was used to estimate reliability of the teammate status scores. The cards on which the students listed their five choices were divided at random into two sets. Scores obtained from the two sets were correlated. The Pearson product moment coefficient of correlation obtained by this method was .87. This would be .93 when corrected by the Spearman-Brown formula. Since the scores are not normally distributed this correlation is spuriously high. A better estimate of reliability is probably obtained by the Rank Order method of correlation. The correlation obtained by this method was .66 or .80 when corrected.

The correlation between the two judgment ratings of skill was .78. This would be an estimated reliability of .88 for the combined judgment ratings. The split halfs of the serving test correlated .72, or .84 for the total test. The volleying test had a split half correlation of .90. The Spearman-Brown formula was not applied to this since only the best five of the ten trials were used as the volleying score.

Relationship Between Factors. The volleyball serving test scores correlated .35 with the scores of the volleying test, .52 with teacher judgment

ratings of skill, and .23 with scores of teammate status. The volleying test scores correlated .71 with ratings of skill made by the teachers and .54 with the scores of teammate status. Scores of teammate status correlated .71 with the rating of skill by the teachers. These correlations are summarized in Table 1.

Conclusions and Recommendations

Teammate status, as measured by student choices, is as closely related to teacher judgment of skill in volleyball as are scores on the French volleying test. This is particularly interesting in view of the fact that the volleying test is considered by many to be the best available single test of volleyball skill.

The correlation of .54 between the scores of the volleying test and the measures of teammate status indicates that the two measures overlap but are not measuring exclusively the same variables. The evidence from Frost's study previously reviewed indicated the following: 1) volleying scores are not related to friendship scores and 2) teammate scores have a consistent relationship to friendship scores. This may mean that one element measured by the teammate status score which is not measured by the volleying scores is a social element. The social adjustment aspect might also influence the teacher judgments of skill. Unfortunately friendship scores were not included in this study so there is no evidence on this point.

Although scores of teammate status can be obtained in a fraction of the time that it takes to administer the volleying test, teammate status is *not* suggested as a substitute measure of skill. It would, however, seem to have real possibilities as a diagnostic tool to aid the teacher in giving guidance and direction. Skill tests supplemented with estimates of teammate status might give the teacher greater insight into the problems of the students.

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The Effect of Shortness of the First Metatarsal Bone on Foot Function*

MARGARET G. FOX
State University of Iowa

SINCE the publishing of Morton's book[1] in 1935, there has been considerable controversy over the causes of foot breakdown in man. Authorities working in the field tend to be either in almost complete agreement or complete disagreement with Morton's concept with few, if any, taking the middle ground.

Morton's concept, stated briefly, is that foot stability is dependent upon the proper distribution of weight. In his so-called "ideal" foot, weight is distributed in the following manner: heel, one half; first metatarsal, one sixth; and second through fifth metatarsals, two sixths. This optimum weight distribution can exist only when the first metatarsal is as long as the second metatarsal and can act, therefore, as the medial line of stress. The medial and lateral lines of stress converge on the longest metatarsal. Therefore, if the second metatarsal is longer than the first, it bears an undue proportion of the total body load. This disturbance of normal lines of stress predisposes the foot to breakdown when subjected to unfavorable circumstances.

The statement is made further, that this is not a definite abnormality, that it is common and apparently an inherited tendency. Morton states that the defect (shortness of the first metatarsal) rarely produces symptoms before adulthood because of the general elasticity of tissue in early life. Later, as the tissues lose their resiliency under excessive strain of an occupational, health or activity nature, such a foot may cause trouble.

In contrast to Morton's theories, we have a number of other hypotheses in regard to causes of general foot breakdown. A number of authorities state that weakness of leg musculature, particularly the supinators of the foot, is the major cause of difficulty. Such persons subscribe to the idea of strengthening exercises in avoidance and treatment of foot difficulties.

Another group of competent observers believe that a tilting of the heel from the neutral into the valgus position is responsible for foot breakdown. This occurs at the subtalar joints and results from the fact that the line of gravity does not fall through the middle of the body of the calcaneus but medial to it by approximately 1.2 centimeters. This provides an essentially

* A more complete account of the study is contained in a dissertation that may be found in the library of the State University of Iowa (June, 1949).

[1] Dudley J. Morton, *The Human Foot*. New York: Columbia University Press, 1935.

unstable position of the posterior part of the foot with a strong rotatory component toward the valgus position.

Still another group subscribes to the theory that the ligaments of the foot provide the support for the foot and that the long leg muscles are relatively unimportant in the maintenance of the position of the foot.

With such a divergence of opinions, it is difficult to place the blame for foot disabilities. In observing both painful and symptomless feet of a large number of college women over a period of several years, it was noted that a high proportion of them, from external examination, might be classed as fitting into Morton's Syndrome. Yet, there was little disturbance of function in the majority of them. This might be explained by Morton's statement that feet possessing this defect are usually free of symptoms until adulthood because of the plasticity of the tissues.

With such a preponderance of deviations and so little objective evidence of any relationship between deviation and function, an investigation seemed pertinent.

Statement of the Problem

The purpose of this investigation was to study the relationship, if any, between relative shortness of the first metatarsal bone of the foot and foot function as measured by various tests and ratings.

Metatarsal length was determined by measurement on x-ray photographs taken of the right foot in the non-weight-bearing position.

Foot function was measured by:

1. an adaptation of the vertical jump
2. an adaptation of the bounce test
3. footprints on which stress was rated and deviation from the midline computed
4. strength of the flexors of the toes as measured on a scale
5. observation and measurement of pronation in the standing position, and
6. observation of shoes for points of wear.

Review of Literature

In considering the bones of the foot, it is of interest to note the varying opinions on the standards for the digital formula for the metatarsals. Morton[2] states that "for ideal foot function, the heads of the first and second metatarsals should be equidistant from the heels." This would imply the following digital formula $1 = 2 > 3 > 4 > 5$. According to Jones,[3] the typical digital formula for the toes is $1 > 2 > 3 > 4 > 5$, but this relationship does not hold true for the metatarsals. Typically, the second metatarsal projects beyond the others. This same author also states:

[2] *Ibid.*, p. 179.

[3] Frederic W. Jones, *Structure and Function as Seen in the Foot*, Baltimore: The Williams and Wilkins Company, 1941, p. 39.

> although the head of the second is, except in rare and abnormal cases, the more projected in the foot, there is a possibility of some slight variation around this mean. Next to the second may come the head of the first, which is itself in advance of the third. . . . or the heads of the first and third may project equally, both being behind the second. Lastly, the third may be in advance of both of them. This is the formula usually accepted by most anatomists as that typical of man.

Jones observes that shortness of the metatarsal, far from being an abnormality, is the accepted normal of all anatomists. If such were not the case, Jones notes, the bulk of humanity would be condemned by the normal disposition of the foot to show departure from normal functioning.

Straus' findings[4] concur with Jones' and indicate as typical digital patterns $2 > 1 > 3 > 4 > 5$ and $2 > 3 > 1 > 4 > 5$. He notes also, that at no time either in fetal or adult life is there a stage in which the heads of the first two metatarsals are equidistant from the heels.

Bruce[5] corroborates Morton's theory by stating that there are distinct evolutionary changes in the metatarsal region which account, in part, for the final form of that region. Among these are: 1) adduction of the first metatarsal, 2) decrease in length of the outer metatarsals, 3) hypertrophy of the first metatarsal, and 4) fixation of the first metatarsal. He points out that lack of adjustment in relative lengths of metatarsals as well as abduction or exaggerated mobility of the first metatarsal are anomalies that disturb the function of the whole anterior segment of the foot.

Elftman and Manter[6] note, among other things, as evolutionary changes in the foot proportion a shortening of the four lateral metatarsals and their phalangeal series.

Hiss[7] contends that shortness of the first metatarsal is more likely a developmental rather than congenital condition resulting from structural forces in the hip joint which necessitate lateral rotation of the leg at the hip. He believes that the metatarsal shortens to keep the plane of the hinge-like action in the metatarsal region at right angles to the direction of travel. Furthermore, he believes the condition develops so slowly that it gives the foot time to adapt to the condition and to develop sufficient function.

Morton cites as his reason for believing that the first metatarsal should be longer the fact that the medial and lateral lines of stress are concentrated on the longer metatarsal as a result of the fulcrum action in this region. The first metatarsal, because of its greater diameter, general sturdiness and larger basal joint surface, is capable of withstanding this strain. But the

[4] W. L. Straus, "The Growth of the Human Foot and Its Evolutionary Significance," *Contributions to Embryology, Carnegie Institute*, Vol. 19, 1927, p. 129.

[5] John Bruce, "Structural Anomalies of the Forefoot in Relation to Some Metatarsal Disturbances," *Edinburg Medical Journal*, **44:** (August, 1937), p. 533.

[6] Herbert Elftman, and John Manter, "The Evolution of the Human Foot," *Journal of Anatomy*, **70:** (October, 1935), p. 66.

[7] John Martin Hiss, *Functional Foot Disturbances*, Los Angeles: University Publishing Company, 1937, p. 45.

second metatarsal is smaller and corresponds in size to the lateral three metatarsals and thus is not capable of bearing this strain structurally.

Morton prefers to think of the foot as a stable base of support with the leg as a "super-structure" maintained in balance over it by muscles rather than to reverse the procedure thus considering the foot movable on the leg with the foot position being maintained by muscular action. If for any reason the structure of the foot is unstable, it is possible for the muscles to maintain the leg in a vertical position over the foot for a short period of time, but like any other group of muscles in the body, the leg muscles are unable to sustain the contraction indefinitely. Hence, Morton believes, faulty foot positions such as pronation are not due to lack of strength but rather to a faulty base. This has been borne out by actual tests of muscle strength, where it was found that the persons with pronated feet frequently had greater strength in the supinator group of muscles.

Jones,[8] who is an advocate of the theory of muscular insufficiency as the cause of foot breakdown, states that the tendons of the muscles help in maintenance and restoration of the long arch not only by contracting from below, but also, in the case of the tibialis anterior and peroneus tertius, by pulling the dome of the long arch upward from above. He concludes that the last of the functional safeguards of the longitudinal arch are the short intrinsic muscles, which are very important functionally.

Willis[9] and Keith[10] agree with the concept that the muscles are all important in the support of the longitudinal arch and that support from ligaments comes into play only after the muscles have failed. Steindler[11] maintains that the muscles are the first line of defense in the maintenance of normal configuration of the foot with ligamentous resistance against external forces depended upon only after muscular resistance has failed.

Jones,[12] after carefully surveying the work of many of the above authors in regard to the theory of muscular support of the foot, found by experimentation that the tension stresses in the arch are borne chiefly by ligaments with the long leg muscles bearing not more than twenty per cent of the total tension stresses. He concludes, therefore, that the most important factors, quantitatively, in the support of the arch are the plantar ligaments and plantar aponeurosis with the short plantar muscles next most important.

Still another theory of possible cause of foot breakdown is advanced by Schwartz et al.,[13] as they disagree with the theory of muscular support

[8] Frederic W. Jones, *op. cit.*, p. 258.

[9] Theodore A. Willis, *Function of the Long Plantar Muscles*, pp. 150–6.

[10] Arthur Keith, "History of the Human Foot and Its Bearing on Orthopedic Practice," *Journal of Bone and Joint Surgery*, **11:** (January, 1929), p. 12.

[11] Arthur Steindler, *The Mechanics of Normal and Pathological Locomotion in Man*, Baltimore: Charles C. Thomas, 1935, p. 266.

[12] Russell L. Jones, "The Human Foot, An Experimental Study of Its Mechanics and the Role of Its Muscles and Ligaments in the Support of the Arch," *The American Journal of Anatomy*, **68:** (January, 1941) p. 22.

[13] Schwartz, and others, "Useful Methods of Examination as Related to the Cause and Treatment of Painful Feet," *Physiotherapy Review*, **19:** (January, February, 1939) p. 22.

of the foot as the first line of defense in foot stability. These authors state: "the presented evidence from precision records indicates that there isn't involuntary muscular protection against pronation in stance and locomotion." Their evidence indicated that pronation and foot strain cannot be avoided by muscular contraction alone. It is the valgus position of the calcaneus which they have found to be the primary factor in faulty foot position. Their study indicates that the posterior tibial muscle, which is a muscle generally accepted as effective in the correction of pronation, does not reflexly contract to prevent pronation either in stance or in the stance phase of locomotion.

Graham[14] and Jordan[15] both agree with Schwartz et al. that the majority of the foot disorders, regardless of their manifestations, originate in the valgus position of the heel.

Morton, while admitting the heel is important for its functional role in both stance and locomotion, still believes that the postural security of the heel as well as the entire foot is directly dependent on the radiating spread of the metatarsals.

It can readily be seen that there is considerable controversy over the cause of foot instability. Muscular insufficiency, lack of ligamentous support, tilting of the calcaneus and lack of support on the medial side of the foot due to shortness of the first metatarsal all have their proponents. It seems rather obvious that study of this problem is indicated.

Procedure

In designing the experiment, it was planned to select two widely divergent groups with respect to comparative lengths of the first and second metatarsals. These groups were to be compared by using the critical ratio, applied to the mean scores of the various tests taken by the groups. It was necessary, therefore, to set up some screening device that would isolate these two groups for study. The following items were included in the examination: difference in length between the first and second metatarsals, contracted toes, callouses and prominence of the first metatarsal cuneiform joint, as measures directly related to selecting subjects for metatarsal length. Scaphoid and malleolus prominence, knee cap roll in or out, and weight on the inside of the foot in walking were selected as measures of pronation, while measures included for general interest value included corns, hallux valgus, angle of walk or toeing out, pain or fatigue, plantar warts, and athlete's foot.

Difference in length of metatarsals is difficult to detect particularly in the heavily muscled or fat foot. In such cases the examiner plantar flexed the subject's toes at the metatarsal phalangeal joint while applying pressure from below to bring out the heads of the metatarsals more clearly. The examiner then laid a steel rule on the dorsum of the first metatarsal

[14] James Graham, "Weak Foot: Pathogenesis and Treatment," *American Journal of Surgery*, **35:** (March, 1937) p. 498.

[15] Henry H. Jordan, "Foot Problems in Wartime," *Archives of Physical Therapy*, **24:** (September, 1943) p. 527.

and read the difference between the forward projection of its distal end and that of the second metatarsal. The rule had been previously prepared with each three millimeters representing one degree of difference so readings could be taken directly. This measure was then designated as estimated difference in metatarsal length. Callouses were indicated by recording the number of the metatarsal under which they were found. Scaphoid and malleolus prominences were graded by noting whether a vertical dropped from these two points lay lateral or medial to a line drawn to connect the most medial projection of the heel and first metatarsal phalangeal joint. For each quarter of an inch deviation medially from the heel-toe line, one degree of deviation was recorded. Lateral deviations were scored as zero. Hallux valgus was scored by placing the feet together and noting the deviation of the proximal phalanges. For each one-fourth inch of deviation, one degree of deviation was recorded. The remainder of the measures were recorded as absent, slight, moderate, or severe.

The screening examination was given as part of the Basic Skills Testing Program in the fall to all entering freshmen women at the State University of Iowa.

All of the cards of the subjects rated as having no estimated difference in length between the first and second metatarsals were reviewed for inclusion in the experimental group and those with marked deficiencies in other parts of the examination were discarded. Those with marked estimated difference in metatarsal length (three or four degrees) were automatically included in the group at the other extreme. In the group with no estimated difference in metatarsal length, fifty were tested, while of those with marked estimated difference, thirty seven were tested.

X-ray photographs were taken of the right foot of all subjects in the weight bearing and non-weight bearing positions. The following measurements were made on the x-ray film with white ink: actual difference in metatarsal length on the non-weight-bearing film and digital length of the weight bearing film. A vertical was erected bisecting the shaft of the second metatarsal and lines were drawn at right angles to the vertical and tangent to the heads of the first and second metatarsals. The difference between these lines was scored as the actual difference in metatarsal length. Digital length was measured by noting the difference between parallel lines drawn tangent to the soft tissue outlines of the first and second digits on the weight bearing film. When the first metatarsal or digit was longer than the second, the actual difference was recorded positively, while negative readings were recorded when the second digit or metatarsal was the longer.

An attempt was made to measure pronation by noting differences between the weight bearing and non-weight bearing films, but after a number of attempts, this was abandoned.

A careful survey of the literature revealed very few tests of foot function. From those available, the following items were selected: vertical jump[16], toe

[16] T. K. Cureton, "Fitness of the Feet and Legs," *Supplement to the Research Quarterly*, **12**: (May, 1941), 368-381.

flexor strength[16], and bounce test.[17] Each of these was modified in an attempt to make the test more valid. In the vertical jump, the depth of the crouch was controlled and the use of the arms eliminated. In the toe flexor strength test, the foot and leg were isolated more completely for testing by re-designing the apparatus used by Cureton. In the bounce test, an attempt was made to improve balance by using straps on the feet which the student could grasp in place of grasping the ankles, and splints on the arms to prevent bending the elbows to relieve the strain on the legs.

TABLE 1

Test reliabilities and intercorrelations

		VERTICAL JUMP	TOE FLEXOR STRENGTH NORMAL	TOE FLEXOR STRENGTH SUPINATED	RELIABILITY
	N	*r*	*r*	*r*	*r*
Vertical jump	81	—	—	—	0.86
Toe flexor strength					
Normal	81	0.10	—	—	0.96
Supinated	81	0.08	0.72	—	0.92
Bounce	81	0.08	0.08	−0.03	—

TABLE 2

Coefficients of correlations between actual metatarsal length and tests

	N	*r*
Bounce	81	−0.02
Vertical jump	81	−0.02
Toe flexor strength		
Normal position	81	0.05
Supinated position	81	0.00
Difference between normal and supinated readings of toe flexor strength	81	0.04

TABLE 3

Coefficients of correlations between actual metatarsal length and physical findings

	N	r
Estimated difference in metatarsal length	81	0.66
Length of toes	81	0.56
Angle of walk	81	0.16
Hallux valgus	81	0.16

Pronation was measured by ratings and also by measuring heel cord deflection. Pressure points and angle of walk were measured on footprints.

Analysis of Data

Three to five readings were taken on each part of the vertical jump and toe flexor strength tests. The number varied with the consistency of the

[17] M. Gladys Scott, Margaret Mordy, and Marjorie Wilson, "Validation of Mass-Type Physical Tests of Work Capacity," *Research Quarterly*, **16:** (May, 1945), 128–139.

TABLE 4

Comparison of mean metatarsal length of groups dichotomized on the basis of the presence or absence of certain physical conditions*

	N†	MEAN	STANDARD DEVIATION	CRITICAL RATIO	LEVEL OF SIGNIFICANCE
					%
Callouses under second metatarsal				2.35	1
a. Present	27	−3.52	3.08		
b. Absent	52	−1.81	3.05		
Claw toes				0.42	50
a. Present	14	−2.50	2.85		
b. Absent	61	−2.14	3.07		
Pain or fatigue				2.17	2
a. Present	11	−4.73	3.52		
b. Absent	57	−2.30	2.65		
Pressure points under second metatarsal				12.01	0.1
a. Present	57	−3.28	2.83		
b. Absent	22	−0.36	3.10		
Prominence of first metatarsal cuneiform joint				3.02	0.1
a. Present	24	−3.63	3.40		
b. Absent	48	−1.60	2.18		
Weight on inside of foot in walking				1.60	7
a. Present	11	−4.09	3.40		
b. Absent	52	−2.19	2.18		
Pronation rating				2.38	1
a. Present	22	−3.59	2.76		
b. Normal	34	−1.59	3.44		

* Difference between first and second metatarsals measured in millimeters.

† The variation in N is due to discarding of cases about which there was a question or where data were incomplete.

TABLE 5

Coefficients of correlation between pronation rating, tests, and physical findings

	N	r
Vertical jump	80	0.00
Toe flexor strength—normal	80	0.06
Bounce test	80	0.03
Scaphoid measurement		
Right foot	61	0.46
Left foot	59	0.46
Malleolus measurement		
Right foot	61	0.46
Left food	59	0.43
Heel cord deflection	79	0.43
Angle of walk		
Right foot	80	0.02
Left foot	80	0.03
Rating of right and left feet	80	0.88

performer. Coefficients of reliability were computed by correlating the scores on the last trial with the median score for all the trials.

None of the measures of foot function correlate with shortness of the first metatarsal and all have low intercorrelations. However, as they have been found to be valid tests of foot strength, power and endurance by other investigations, it is probable that there is little or no relation between relative length of metatarsals and foot function as measured by these tests, at least as far as this population of college women is concerned.

If additional study were to be done on this topic, it would be convenient if subjects could be selected by an examination of the foot without x-rays. However, the coefficient of correlation between the original estimate and x-ray findings in this study is too low to make such a recommendation. Digital length has been suggested as a method of screening subjects for shortness of the first metatarsal. The coefficient of correlation between the actual metatarsal length as measured on the x-ray and the toe length was not high enough to make it a valid diagnostic sign.

Although the number complaining of pain was small, the number increased directly with the increase in degree of metatarsal shortness.

Conclusions

1. Apparently, there is little significant relationship between shortness of the first metatarsal and foot function of young adult women of college age.
2. External examination alone is not a valid test for determining metatarsal shortness.
3. Digital length, while related, is not a significantly valid criterion to be used for prediction of metatarsal length in individuals.
4. Angle of walk and hallux valgus are only very slightly related to shortness of the first metatarsal.
5. Presence of callous and pressure under the head of the second metatarsal as shown on the footprints or examination are highly significant in relation to shortness of the first metatarsal.
6. Prominence of the first metatarsal cuneiform joint is also very closely related to shortness of the first metatarsal.
7. Pronation as determined by a rating appears to be definitely related to shortness of the first metatarsal, but does not appear to be related to the tests of foot function used in this study.
8. Carrying the weight on the inside of the foot in walking and prominence of the scaphoid and medial malleolus appear to be definitely related to pronation as determined by rating.
9. Heel cord deflection, while it offers possibilities for further study as an objective test of pronation, is not a valid measure as administered in this test.
10. Angulation of the patella, apparently, is not a good indication of pronation.
11. Pain and fatigue seem to be more prevalent among those with short first metatarsals.

Suggestions for Further Study

1. Measurement of hypertrophy of the cortex of the metatarsals to determine its relationship to shortness of the first metatarsal at this age.
2. Further study of individuals with shortness of the first metatarsal with x-ray photographs taken from the medial side of the foot in a horizontal plane to determine the part played by the sesamoids in compensating for shortness of the first metatarsal.
3. Study and refinement of the scales of scaphoid and malleolus prominence and their relation to pronation.
4. Study of heel cord deflection with view to improving accuracy in judging the center line of the tendon of Achilles.
5. Study of the walk of individuals of known metatarsal length by means of movies to determine the relationship of metatarsal length to rotation at the hip joint.
6. Study of the walk of individuals of known metatarsal length by means of movies to analyze the use of the foot in the push off phase of locomotion.
7. Repetition of studies of foot function in relation to shortness of the first metatarsal in an older age range.

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Status of Statutory Health Instruction in the United States

H. Kent Farley
Oregon College of Education
Monmouth, Oregon

To WHAT extent is health instruction in the elementary and/or secondary schools of the several states and the District of Columbia required by statute? To what extent is the teaching of various areas of health required? In an effort to secure data bearing on these questions and others, a letter of inquiry was sent during the school-year 1948–1949 to the chief educational officers of the several states and the District of Columbia. Forty-two replies were received from the forty-nine inquiries, a return of approximately eighty-six per cent. Data concerning the seven states not replying were secured from other sources that were deemed valid (1, 2).

Answers to four questions were sought in the above-mentioned letter of inquiry. The questions asked were:

1. Is health instruction (not physical education) *required by statute* in your state? If so, at what level or levels?
2. Does your statute specify a title for the required course in health? If so, what is that title?
3. Does your statute require that a course of study be developed? If so, by whom? For what levels?
4. In what areas (effects of alcohol; safety; etc.) is health instruction required by your statute?

Data bearing on question one above are given in detail in column two, Table 1. Attention is directed to the fact that thirty-two states replied that they had some type of health instruction required by statute. However, Idaho, Maryland, Missouri, Nebraska, and New Hampshire in replying to question one indicated they did not have any statute requiring health instruction, although, in replying to question four, they indicated that at least one area was required by statute. It would seem, therefore, that the statutes of thirty-seven states actually did require that some type of health instruction be given in their elementary and/or secondary schools.

Health instruction was required in grades one through twelve by twenty-five states; in grades one through eight by four states; while grade-ranges of one through nine, one through ten, and nine through twelve were indicated by one state each. In other words, of the thirty-seven states indicating that some type of health instruction was required by statute, approximately sixty-seven per cent specified such instruction must be given in all elementary and secondary grades.

TABLE 1

State statutory requirements for health instruction

STATE	INSTRUCTION REQUIRED	TITLE SPECIFIED	COURSE OF STUDY REQUIRED (Authority)	AREAS IN WHICH HEALTH INSTRUCTION IS REQUIRED BY STATUTE
	Grades			
Alabama	1–12	Hygiene and Sanitation	no	Hygiene and sanitation. Alcohol; tobacco; narcotics
Arizona	none	none	no	None
Arkansas*	1–12	none	no	Part of Physical Education
California	1–12	none	no	Alcohol, narcotics; safety
Colorado	1–12	none	no	Alcohol; narcotics required in all grades
Connecticut	1–12	none	Com. of Education	Safety, all levels. Alcohol third grade and above
Delaware†	none	none	no	None
Florida*	none	none	no	None
Georgia	none	none	no	None
Idaho‡	none	none	no	Alcohol, narcotics required
Illinois	1–9	Physiology and Hygiene	no	Safety; alcohol, narcotics
Indiana	9–12	Health and Safety	State Bd. for H. S.	Alcohol; nutrition
Iowa	1–12	none	State Supt. of Education	Alcohol, narcotics, poisonous substances
Kansas	1–12	Health and Hygiene	State Supt. of Education	Alcohol. Other areas general
Kentucky	1–10	Basic Health	H. S. State Safety Bd.	Other areas general
Louisiana	1–8	none	Local Board	Alcohol, narcotics in 1–8
Maine	1–12	none	Indirect Com. of Educ.	Personal hygiene; community sanitation; safety
Maryland‡	none	none	no	Alcohol, narcotics required by old state law
Massachusetts	1–12	Physiology and Hygiene	no	Alcohol and narcotics; tuberculosis
Michigan	none	none	no	None
Minnesota	1–12	none	Comm. Ed. to Supv. of P.E.	Alcohol and narcotics; morals
Mississippi	1–12	none	no	Narcotics; safety
Missouri‡	none	none	no	Alcohol though not specified as to grade
Montana†	1–12	none	no	General areas
Nebraska‡	none	none	no	Attention to alcohol and narcotics required
Nevada	1–12	Physiology and Hygiene	no	Alcohol and narcotics
New Hampshire‡	none	none	no	Alcohol and narcotics required by old law
New Jersey	1–12	none	State Dept. or Local Bd.	Safety; first aid; home nursing; alcohol and narcotics
New Mexico	none	none	no	None
New York	1–12	Health Teaching	State Dept. of Education	Mental health; nutrition; personal hygiene; dental health; first aid; safety; disease prevention; Alcohol and narcotics

TABLE 1—*Continued*

STATE	INSTRUCTION REQUIRED	TITLE SPECIFIED	COURSE OF STUDY REQUIRED (Authority)	AREAS IN WHICH HEALTH INSTRUCTION IS REQUIRED BY STATUTE
	Grades			
North Carolina	1–8	none	State Supt. Ed.	Safety; alcohol and narcotics
North Dakota	1–8	none	State Bd. Education	Safety; alcohol ....
Ohio	none	none	no	none
Oklahoma	1–12	none	no	Law passed, no appropriation made
Oregon	1–12	none	Supt. of Public Instruction.	Structure-function; first aid; safety; personal hygiene; communicable disease; selection services; alcohol-narcotics; mental hygiene; physiology of exercise; health and sanitation; nutrition
Pennsylvania	1–12	Health Education	Chief of Health P.E.	Safety; alcohol
Rhode Island	none	none	no	none
South Carolina	1–8	none	no	Safety
South Dakota	none	none	no	none
Tennessee†	none	none	no	none
Texas	1–12	Physiology Hygiene	State Supt. Education	Alcohol and narcotics
Utah	1–12	Physiology Hygiene	State Bd. of Education	Sanitation; communicable diseases; alcohol and narcotics
Vermont	1–12	none	no	Alcohol and narcotics
Virginia	1–12	none	State Ed.	Safety; Alcohol, narcotics
Washington	1–12	Physiology Hygiene	no	Effects of exercise; Alcohol and narcotics
West Virginia	1–12	none	no	Alcohol and narcotics
Wisconsin*	none	none	no	none
Wyoming	1–12	none	no	Alcohol and narcotics
District of Columbia*	none	none	no	none

* No reply. Data taken from F. S. Stafford, *State Administration of School Health, Physical Education and Recreation*. Office of Education, Bulletin 1947, No.13, 1947.
† No reply. Data taken from mimeographed report of Committee on Legislation. Society of State Directors of Health and Physical Education, April 1, 1946.
‡ Reported no statute; however, reported alcohol one area required taught.

Replies to question two (as tabulated in column three, Table 1) revealed that four states specified the title, Physiology and Hygiene, for their required program of health instruction. Seven other states indicated seven different titles. Frequently the laws seemed to mean that instruction was to be given in the field of hygiene, physiology, or health without intending that those terms should constitute the title of the required program of health instruction.

The development of a course of study for the health instruction program was required by statute in seventeen states. The state board of education and the chief educational officer of the state were the two sources most frequently held responsible for developing that course of study, the former in seven states, and the latter in eight states. One state placed the responsibility with the local board of education and one state with the state health and physical education officer. Column four, Table 1, gives the tabulated data relative to that question.

Replies to question four (as tabulated in column five, Table 1) indicated that only two or three areas of health were consistently specified by statute in the several states. The area of alcohol, stimulants, and narcotics (as they effect the human body) was the area most frequently mentioned, thirty-one states having such statutory requirement. Instruction in safety was required in fourteen states. Four states required instruction in the area of sanitation. Three states required instruction in nutrition. Two states required instruction in the area of communicable diseases. Other areas reported were too general in nature or mentioned by only one state as being required by statute.

Based on conditions existing at the time of this study (1948) it can be said in summarization that:

1. Seventy-five per cent of the states required by statute that health instruction be given in the elementary and/or secondary grades.

2. Of the states requiring health instruction by statutory act, sixty-seven per cent required that such instruction be given in grades one through twelve, eleven per cent grades one through eight, three per cent grades one through ten, three per cent grades one through nine, three per cent grades nine through twelve, while thirteen per cent did not specify any particular grade-range.

3. Specification of title by statute was not generally engaged in as evidenced by the fact that only twelve states made such provision.

4. Approximately thirty-four per cent of the states made statutory provision for the development of a course of study for the health instruction program. Responsibility for the development of that course of study was primarily lodged with either the state board of education or the chief state educational officer, seven states indicating the former and eight states the latter.

5. Better than sixty-three per cent of the states required by statute that instruction be given in the effects of alcohol, stimulants, and narcotics on the human body.

6. Safety instruction was required by statute in approximately twenty-eight per cent of the states.

7. Less than eight per cent of the states required by statute that instruction be given in sanitation.

8. Only six per cent of the states required by statute that nutrition be taught.

9. The teaching of communicable diseases was required by statute in four per cent of the states.

10. Only one state required by statute that some instruction be given relative to the effects of tobacco on the human body.

11. Areas reported by one state each were; poisonous substances, tuberculosis, home nursing, dental health, first aid, disease prevention, structure and function of the human body, selection and use of health services and health products, physiological effects of exercise on the human body, mental hygiene, and community health.

12. Oregon, with eleven areas specified, led all other states in the total number of areas in which health instruction was required by statute.

In conclusion mention should be made of the fact that no attempt was made to ascertain the extent of health instruction being required in the several states and the District of Columbia by means of rules and regulations. It was believed that such requirements were of a more transitory nature and would probably present more of a shifting picture than statutory requirements would present.

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The Status of Boxing in Institutions of Higher Learning

Carlton R. Meyers
Yale University
New Haven, Connecticut

THE PLACE of boxing in educational programs is a controversial issue not only among physical educators but also among educators in general. In 1940 Kenney and his associates instigated this controversy by focusing the attention of others upon it through the results of an evaluation of boxing as a college activity (3). The problem still continues.

Basic to a study and evaluation of boxing in colleges and universities lies the need for a composite picture of current practice and opinion relating to boxing—the status of boxing in institutions of higher learning (4).[1] To fulfill this need questionnaries were submitted to 794 institutions of higher learning enrolling men in the United States. Each institution received two questionnaires; one for the person directly responsible for physical education for men, and another for the director of health services. The questionnaire intended for physical education administrators dealt with facts concerning current practice and opinion relating to boxing. The document directed to health service administrators was designed to ascertain the prevalence of significant injuries in boxing as well as opinion about the activity.

Findings

The findings of this questionnaire study comprised a 78 per cent response; 620 of 794 institutions having replied. During the academic year 1948–49, as indicated by the replies, 263 institutions offered boxing in one or more of the following: physical education class program; intramural program; and intercollegiate program. Boxing was conducted in these programs by 228, 123 and 59 schools, respectively. The number of institutions offering boxing during 1948–49 included 143 under public control, 56 private colleges and universities, and 64 denominational schools. In lieu of intercollegiate competition three colleges sponsored participation in Golden Gloves tournaments, and one school enabled students to enter Amateur Athletic Union competition.

[1] The data presented herein comprised an integral part of "An Evaluation of Boxing as a Sports Activity in Institutions of Higher Learning," a study approved for sanction by the Executive Council of the College Physical Education Association in March 1949.

Table 1 discloses the extent to which boxing was sponsored by responding institutions both during 1948–49 and within the past decade (beginning with the academic year 1939–40). As shown by this table, 62 colleges and universities had sponsored the activity in one or more of the forementioned programs within the past decade but have subsequently discontinued all boxing. During this period an additional 50 schools have dispensed with the activity in part. Lack of a qualified instructor, limited facilities and equipment, and little student interest accounted for 59, 52 and 40 per cent of the discontinuance of boxing from physical education class, intramural and intercollegiate programs, respectively. It was noted that the majority of reasons given by respondents for dropping boxing may be categorized as complicating factors attributable to the nature of the activity. For example, the recommendations of professional organizations and administrative difficulties, two of the reasons mentioned by respondents, may be

TABLE 1

Boxing in colleges and universities

	PHYSICAL EDUCATION CLASS PROGRAM		INTRAMURAL PROGRAM		INTER-COLLEGIATE PROGRAM		TOTAL REPORTING	
	No.	%	No.	%	No.	%	No.	%
Institutions sponsoring boxing, 1948–49	228	36.8	123	19.8	59	9.5	263	42.4
Institutions dropped boxing in past decade	48	7.7	54	8.7	41	6.6	62*	10.0
Institutions without any boxing in past decade	344	55.5	443	71.5	520	63.9	295	47.6
Total	620	100.0	620	100.0	620	100.0	620	100.0

* This figure includes only those institutions that have discontinued all boxing.

classified as complicating factors accruing from the nature of the activity.

During 1948–49 a mean of 150 students received instruction in the physical education class programs of 200 institutions, which furnished such statistics. The number ranged from 9 to 2500 students. For the same period 95 schools reported a mean of 64 participants in a range from 12 to 300 for boxing in intramural programs. The average number of contestants in the intercollegiate boxing programs of 54 institutions was 27; the range being from 6 to 80.

Boxing instruction in the physical education class program was offered in the majority of institutions as an elective during 1948–49. Table 2 shows the various ways in which boxing instruction was given with the frequencies of occurrence.

Table 3 reveals the tabulated response to an inquiry as to the safety measures used for boxing during 1948–49 in the physical education class program, and for competition and practice in intramural and intercollegiate

programs. The tabulation may appear to indicate that relatively few institutions utilized any precautionary measures. Obviously, the recorded response reflects the frequency of mention accorded to the various measures which were deemed to be most important by respondents. Some repliers listed only one item, e.g., close supervision, whereas others were more definitive and delineated equipment and other controls. For the intercollegiate program one-third of the reporting institutions designated compliance with regulations of the National Collegiate Athletic Association. Conformance to these regulations insures provision of other specific items enumerated in the tabulation; such as hand wraps, groin protection, padded floor, medical examination before bouts, and presence of a physician at contests.

Relative to the prevalence of significant injuries in boxing, respondents were requested to furnish available facts concerning such injuries and their incidence as sustained during the past decade in all forms of boxing con-

TABLE 2

Boxing instruction in physical education class programs during 1948–49

OFFERED AS*	INSTITUTIONS	
	No.	%
Requirement (including requirement reported for teacher training programs in physical education only)	87	35.8
	(19)	(7.8)
Elective	103	42.4
Elective to meet a requirement in general area of combative activities	37	15.2
Not specified	16	6.6
Total	243	100.0

* Instruction was offered by 11 institutions in two of these ways, and by two schools in all of the possibilities.

ducted by their respective institutions. Table 4 discloses the reply to a query as to serious cases of physical or mental impairment that were directly traceable to participation in boxing at reporting institutions within the past decade. Table 5 contains a tabulation of the response from the 325 institutions that have sponsored boxing regarding other significant health disturbances directly traceable to participation in boxing since 1939. In these two tables the response of medical doctors (M.D.) serving as health service directors has been differentiated from persons not trained as physicians (Not M.D.). Also, injuries incurred at institutions sponsoring boxing only in the physical education class program have been segregated from those sustained at institutions which conducted competitive boxing in intramural or intercollegiate programs.

The incidence of injury in boxing at institutions of higher learning was computed from the number of participants, injuries and knockouts for both the academic year 1948–49 and the preceding nine years of the past

TABLE 3

Safety measures employed for boxing in 1948–49

SAFETY MEASURE REPORTED	NUMBER OF INSTITUTIONS				
	Physical education class program	Intramural program		Intercollegiate program	
		Competition	Practice	Competition	Practice
Head guards	122	57	47	13	43
Head guards—optional	4		2		
Head guards with face masks	7	1	2		2
Head guards with face masks—optional	2		1		1
No head guards	3	1			
Teeth protectors	54	29	20	5	20
Groin protectors (cups)	12	12	8	1	2
Abdominal protectors	2	1			
Hand wraps	19	9	5	5	10
Vaseline	1	3	2	1	2
Heavy gloves	21	5	9		5
18 ounce gloves	1				
16 ounce gloves	49	15	11	2	11
14 and 16 ounce gloves	4		1	1	1
14 ounce gloves	16	9	2	1	5
12 ounce gloves	1	3			1
Gloves according to weight classes	1	1			
Good equipment					2
Padded floor	19	7	2	3	3
Regulation ring	5	4			
Thorough medical examination	9	14			1
Medical examination before bouts		1			
Adequate instruction	16	2	2		
Conditioning	13	8	4	2	5
Close supervision	35	11	30	2	13
Stress fundamentals, controlled sparring	4				1
No competition	8				
Proper weight matching	10				2
Even competition—matching according to ability and weight	5	1	3	2	
Only conditioning			1		
Presence of a physician		48	1	1	
Presence of a trainer		4	3		1
Competent officials		6		1	
Comply with NCAA rules		1		17	24
Follow AAU rules				2	
College rules		1			
Shortened rounds	6	8	5		
1 minute rounds	1	1			
Bouts of 2 rounds		6			
Knockdown ends round		2			
Special knockdown rule	1	1			
Fast count refereeing	1	1			
Referee stops bouts early in uneven matches or upon signs of injury		1			
Stopping over-match before official				1	
All necessary precautions	4	5	2	2	
None	10	1	1		

decade. Since these statistics were not readily available at many institutions, the injury incidence presented in Tables 6 and 7 is based on 120 institutions

TABLE 4

Serious cases of impairment attributable to boxing in the past decade

CASE REPORTED	NUMBER OF CASES						
	Class program only		With Competitive boxing		Total		
	Not M.D.	M.D.	Not M.D.	M.D.	Not M.D.	M.D.	Both
Brain concussion			2	17	2	17	19
Dementia pugilistica (punchdrunkness)			1	4	1	4	5
Amnesia			3	2	3	2	5
Intracranial hemorrhage			1*	3†	1	3	4
Signs of mild dementia pugilistica	1		2		3		3
Serious head injury				1		1	1
General paralysis of right side and right extremities				1		1	1
Paralysis of motor occular nerve			1		1		1

* Outcome was fatal.

† Outcome was fatal in one case; motor aphasia and epileptiform seizures in another.

TABLE 5

Significant health disturbances directly traceable to boxing in the past decade

CASE REPORTED	NUMBER OF CASES						
	Class program only		With competitive boxing		Total		
	Not M.D.	M.D.	Not M.D.	M.D.	Not M.D.	M.D.	Both
Cuts over eye	5		18	17	23	17	40
Broken tooth	2		8	22	10	22	32
Dislocated shoulder	1		21		22		22
Fractured hands				13		13	13
Serious nose injury (surgical correction)			1	12	1	12	13
Ruptured tympanic membrane			3	5	3	5	8
Fractured nose			3	1	3	1	4
Persistent headache			1	2	1	2	3
Sprained ankle	3				3		3
Kidney injury	1				1		1
Subcute auricular perichrondritis (cauliflower ear)				1		1	1
Hernia			1		1		1
Nose injury			1		1		1
Fractured jaw			1		1		1
Fractured rib				1		1	1
Fractured tibia and fibula			1		1		1
Dislocated patella			1		1		1

for 1948–49 and 72 schools for the academic years 1939–40 through 1947–48. The accuracy of reported figures remains speculative. For most institutions it is undetermined whether the statistics were secured from actual records or derived by conjecture. Although knockouts are usually regarded as in-

juries by the medical profession, they are distinguished from other injuries in the tables to facilitate comparison of the incidence of generally recognized injuries with previous researches (1, 2). The incidence of injury and knockouts at reporting institutions showed an increase for the academic year 1948–49 over the incidence of injury and knockouts for the academic years 1939–40 through 1947–48. This increase apparently occurred despite alleged emphasis to reduce the hazardousness of the activity, although the possible inaccuracy of reported figures, for academic years prior to 1948–49 in particular, must be recognized.

A section designed to ascertain opinion about the place of boxing in institutions of higher learning was included in both questionnaires. This

TABLE 6

Incidence of injury in boxing during academic year 1948–49

PROGRAM	NUMBER OF PARTICIPANTS	INJURIES		KNOCKOUTS		NUMBER OF INSTITUTIONS
		No.	%	No.	%	
Physical education class program only	2477	7	0.3	8	0.3	34
Including competitive boxing	7058	89	1.3	179	2.6	86
Total	9535	96	1.0	187	2.0	120

TABLE 7

Incidence of injury in boxing during academic years commencing 1939 and ending 1948

PROGRAM	NUMBER OF PARTICIPANTS	INJURIES		KNOCKOUTS		TOTAL NUMBER OF YEARS	NUMBER OF INSTITUTIONS	MEAN YEARS
		No.	%	No.	%			
Physical education class program only	6860	9	0.1	24	0.4	111	22	5.0
Including competitive boxing	22562	178	0.8	424	1.9	269	50	5.4
Total	29422	187	0.6	448	1.5	380	72	5.4

opinion part consisted primarily of statements to which respondents were requested to indicate their judgment by either checking: (+) yes or approval; (−) no or disapproval; or (?) preference being not to express an opinion.

The general response elicited by statements on the questionnaire directed to physical education administrators is recorded in Table 8. Therein the opinion of individuals representing institutions that have had no boxing in the past decade is segregated from the beliefs of persons responsible for physical education for men at institutions that have had boxing during the past decade. The assumption underlying this differentiation is that more reliability can be affixed to opinion based upon experience with the activity than to opinion which is not founded upon experience. However,

it is recognized that some representatives of institutions which have not sponsored boxing of late may have had experience with the activity elsewhere.

In over-all perspective the opinion of physical education administrators was favorable toward boxing. However, opinion concerning intercollegiate boxing was not decisive; the deciding vote lay in the group that was doubtful. It was noted that 49 per cent of the respondents representing institutions that have sponsored some boxing felt the need for more stringent

TABLE 8

Prevalent opinion of physical educators about boxing

	NUMBER OF INSTITUTIONS								
	No boxing			With boxing			Total		
	+	−	?	+	−	?	+	−	?
Desirability of the following:									
Boxing instruction in physical education class program	94	56	16	255	28	9	349	84	25
Competitive boxing in intramural program	71	81	16	159	104	24	230	185	40
Intercollegiate boxing	71	77	16	128	109	43	199	186	59
Boxing can or cannot be controlled so that it warrants inclusion as an activity in:									
Physical education class program	103	47	14	257	27	10	360	74	24
Intramural program	84	65	17	169	94	23	253	159	40
Intercollegiate program	80	66	19	136	100	48	216	166	67
Suitability of the following:									
More stringent controls over competitive boxing than those of NCAA	57	19	70	131	53	87	188	72	157
Mandatory use of headgear *without* face mask in all competitive contests	81	24	41	154	58	48	235	82	89
Mandatory use of headgear *with* face mask in all competitive contests	39	52	50	85	106	59	124	158	109
Required presence of a physician at all contests	113	13	27	236	14	27	349	27	54
Validity of the following:									
Boxing offers a unique type of educational experience not to be found in any other physical education activity	64	75	32	167	85	36	231	160	68
Educational benefits generally credited to boxing can be derived from other sports activities without the dangers present in boxing	106	33	31	125	108	58	231	141	89
If weight of scientific evidence should indicate that competitive boxing presents an unwarranted risk to participants, the educational value would still justify teaching boxing in class program	39	109	29	98	157	33	137	266	62

controls over competitive boxing than the regulations specified by the National Collegiate Athletic Association. Thirty-two per cent of these individuals were undecided on the desirability of more stringent controls.

The opinion elicited by statements on the questionnaire submitted to health service directors is recorded in Table 9. As in Table 8, the response is divided into representatives of institutions that have not sponsored boxing within the past decade and directors at schools which have conducted boxing since 1939. Similarly, Table 10 delineates the opinion of

TABLE 9

Prevalent opinion of health service directors about boxing

	NUMBER OF INSTITUTIONS								
	No boxing			With boxing			Total		
	+	−	?	+	−	?	+	−	?
As commonly conducted, is boxing sufficiently safe and appropriate for college men in:									
Physical education class program	85	59	16	196	42	9	281	101	25
Intramural program	72	66	23	141	79	26	213	145	49
Intercollegiate program	70	60	28	117	82	42	187	142	70
Mandatory use of headgear *without* face mask in:									
Physical education class participation	84	37	22	149	58	24	233	95	46
Intramural competition	83	32	23	139	50	30	222	82	53
Intercollegiate competition	53	42	37	99	74	42	152	116	79
Intramural and intercollegiate practice sessions	84	28	26	155	27	30	239	55	56
Mandatory use of headgear *with* face mask in:									
Physical education class participation	64	50	29	91	100	33	155	150	62
Intramural competition	47	54	35	72	98	43	119	152	78
Intercollegiate competition	30	65	39	43	117	43	73	182	82
Intramural and intercollegiate practice sessions	54	47	34	76	89	42	130	136	76
With control measures indicated above or written in is boxing sufficiently safe and appropriate for college men in:									
Physical education class program	110	28	17	216	21	11	326	49	28
Intramural program	95	36	23	160	49	24	255	85	47
Intercollegiate program	84	42	25	130	66	35	214	108	60

TABLE 10

Prevalent opinion of medical doctors serving as health service directors about boxing

	NUMBER OF INSTITUTIONS								
	No boxing			With boxing			Total		
	+	−	?	+	−	?	+	−	?
As commonly conducted, is boxing sufficiently safe and appropriate for college men in:									
Physical education class program	12	9	2	47	14		59	23	2
Intramural program	9	10	3	34	22	4	43	32	7
Intercollegiate program	7	10	5	24	32	6	31	42	11
Mandatory use of headgear *without* face mask in:									
Physical education class participation	12	3	2	38	13	6	50	16	8
Intramural competition	11	2	3	36	11	9	47	13	12
Intercollegiate competition	5	5	4	26	15	11	31	20	15
Intramural and intercollegiate practice sessions	9	3	3	36	8	11	45	11	14
Mandatory use of headgear *with* face mask in:									
Physical education class participation	10	10	1	21	25	8	31	35	9
Intramural competition	8	6	3	19	19	12	27	25	15
Intercollegiate competition	7	5	4	16	21	12	23	26	16
Intramural and intercollegiate practice sessions	9	6	3	21	18	11	30	24	14
With control measures indicated above or written in is boxing sufficiently safe and appropriate for college men in:									
Physical education class program	14	4	3	34	10		48	14	3
Intramural program	10	6	4	38	21	3	48	27	7
Intercollegiate program	7	9	4	17	27	6	24	36	10

TABLE 11

General comments of physical educators about boxing

COMMENT	NUMBER OF INSTITUTIONS		
	No boxing	With boxing	Total
Eliminate competitive boxing	5	24	29
Since:			
It cannot be controlled	2	5	7
Nature of sport is such that it cannot be controlled by rule or equipment to offset major hazard—head injuries		2	2
Cannot control matching; too much emphasis on winning		2	2
Boxing is too dangerous above physical education classes due to intensity		4	4
Nature of the activity is not educationally sound; objective of boxing is not reconcilable as an objective of education	2	7	9
Limit boxing to class instruction as a phase of safety skill development	1	3	4
An anti-social sport promoted among those needing socializing team games		1	1
Eliminate boxing	4	6	10
Since:			
Success depends upon ability to injure	2	3	5
Possibility of head injury overshadows any educational advantages not covered by other sports	1	1	2
Continuous hitting on head is bound to leave detrimental results		1	1
Evidence indicates it is undesirable	1		1
Recommendations of professional organizations cited as basis for elimination of boxing		1	1
Non-controllable effects of spectators on participants ruin competitive boxing		5	5
Boxing can be a valuable, wholesome educative experience, if controlled		4	4
Boxing is a good sport and can be controlled		3	3
Skeptical that boxing instruction is dangerous		3	3
Boxing is a good sport offering variety, nothing unique	1	2	3
Success of competitive boxing is dependent upon proper financial support and supervision	1	2	3
Competitive boxing would be acceptable with scoring system which de-emphasized hard blows and stressed "hit and get away" principle	2	1	3
No other sport teaches the valuable lessons of boxing		2	2
Boxing in class and intramural programs is good if controlled		2	2
Boxing instruction is desirable in physical education class program as part of general education		2	2
No evidence exists that competitive boxing is harmful under NCAA rules; research evidence is needed	1	1	2
Approve of boxing with:			
Head guards and face masks	1		1
Long training period in defense		1	1
Complete record of internal and head injuries		1	1
No place for boxing as now promoted by many institutions		1	1
Wrestling is a better self-defense, combative activity		1	1
Boxing affords competition for the small boy		1	1
Those desirous of boxing should be allowed to box		1	1
Need boxing in our educational programs; too many boys are becoming "soft"		1	1
Headgear defeats purpose of boxing; makes for careless defense		1	1
Biggest problem in competitive boxing is matching according to ability	1		1
See neither much danger in boxing nor reason for promoting it unduly	1		1
Studies of possible permanent injury indicate that boxing must be carefully controlled	1		1
Boxing is not administratively feasible; too expensive, dangerous, and impractical	1		1

medical doctors serving as health service directors at institutions which have or have not conducted boxing recently. While the viewpoints of medical doctors are included in Table 9, these beliefs are presented separately in Table 10 in view of the specialized training and interest in the maintenance of health which characterize their proponents.

As in the case of physical educators, the opinion of health service directors was generally favorable toward boxing. The majority deemed boxing sufficiently safe and appropriate for college men. However, the percentage of approval was greater for instructional boxing than for competitive boxing. It was noted that the plurality of all medical doctors and of those serv-

TABLE 12

Additional safety measures deemed necessary by health service directors for intercollegiate competition

SAFETY MEASURE	NUMBER OF INSTITUTIONS			
	No boxing	With boxing		Total
		Not M.D.	M.D.	
Close supervision	15	12	6	33
Proper conditioning for participants	7	11	3	21
Adequate instruction	8	8	2	18
Complete medical examination	4	9	5	18
Proper matching (including ability)	1	6	2	9
Sufficient floor padding	1	4	2	7
Teeth guards		5	2	7
Groin protectors (cups)	1	4	1	6
Competent officials	2	2	1	5
14 ounce gloves		3	1	4
Hand wraps	1	2	1	4
Stop bout when danger appears imminent	3		1	4
Heavier gloves	1	1	1	3
16 ounce gloves		3		3
Headgear		2	1	3
Follow-up of injuries and knockouts	1		1	2
Revised scoring—reduce or eliminate head blows	1	1		2
12 ounce gloves	1	1		2
Shortened rounds		1		1
No competition			1	1
Abdominal supporter		1		1

ing at institutions that have sponsored some boxing disapproved of intercollegiate boxing for college men both as commonly conducted and with additional control measures and supervision of health factors.

Space was provided on both questionnaires for enlargement of any viewpoints about the place of boxing in higher education. In Table 11 the key statements or basic tenets of comments made by physical education administrators have been categorized. The comments expressed on the health questionnaire were similar. In Table 11 the various opinions are listed along with their frequencies of mention. Since more physical educators who opposed boxing as an educational activity expressed comments than those

who favored its acceptance, these notations do not present an accurate, proportionated picture of general thought. Nevertheless, they do illustrate the many and varied viewpoints about the activity.

Respondents to the questionnaires were requested to enumerate any additional safety measures deemed necessary for boxing in the various programs. Table 12 delineates the measures suggested for intercollegiate competition by persons responsible for health services. Close supervision was mentioned most frequently on the health questionnaire as an additional safety measure for all programs and practice sessions. Adequate instruction, complete or thorough medical examination, and proper conditioning for participants comprised the next most frequently mentioned safety measures for all programs. These same controls were among those suggested the greatest number of times on the questionnaire submitted to physical education administrators.

SUMMARY

The findings of a questionnaire study to ascertain the status of boxing in institutions of higher learning have been presented. These findings disclosed the extent to which boxing has been sponsored since 1939, facts dealing with its conduct, and opinion about the activity as expressed by physical education administrators and persons directly responsible for health services.

A 78 per cent response was obtained from 794 colleges and universities in the United States. Forty-two per cent of the responding institutions sponsored boxing (instructional, competitive, or both) during the academic year 1948–49.

Boxing was regarded as both desirable and controllable in physical education class, intramural and intercollegiate programs by the majority of responding physical education and health service administrators. A greater percentage favored the activity in the physical education class program than approved of competitive boxing in the other two programs. The plurality of physical educators favored more stringent controls over competitive boxing than those generally followed. The majority of medical doctors serving as health service directors disapproved of intercollegiate boxing.

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Achievement Tests for Beginning and Intermediate Tennis

MARION R. BROER
University of Washington, Seattle
and
DONNA MAE MILLER
University of Colorado, Boulder

THE WOMENS' PHYSICAL EDUCATION Department at the University of Washington, through its Grading Committees,* has undertaken a long-term project which is designed to standarize and improve grading procedures in various activities. This department is attempting to devise some objective, reliable, and valid means of measuring the achievement of the students in various activities in both the skill and knowledge areas.

It is the purpose of this article to report the progress made in setting up such tests in tennis together with certain statistical data obtained to date.

Comprehensive Knowledge Test

I. Original Test

A. Content

The various members of the staff teaching tennis conferred and discussed subject matter to be covered in beginning and intermediate tennis courses. Test items, for the most part, were based on the minimum essentials set up as standards for teaching by this committee. As will be pointed out later, this procedure was used to establish the curricular validity of the test.

An experimental test was given to 87 students. This original test consisted of 100 questions which were separated according to content into the following question types:

Part I	*True-False*
	Position, Timing, Footwork
	Fundamental Strokes
	Advanced Strokes
Part II	*Multiple Choice*
	Strategy and Court Position

* Other members of the Tennis Grading Committee were Helen McLellan, Leone Rulifson, Kathro Kidwell, Katharine Fox, and Emma Spencer.

Part III *Completion*
History, Events, Equipment
Part IV *Matching*
Advanced Strokes
Part V *Yes-No*
Rules and Scoring
Part VI *Identification*
Court Markings
Strategy

The test questions and directions were put in mimeographed form and given to the students who were asked to make notations on any items which they could not understand or which they questioned.

B. Statistical Analysis

1. Reliability

The reliability of the original test was taken on all 87 cases and was computed to be .84 as determined by the split halves method and the Spearman-Brown Formula.

2. Curricular Validity

To satisfy the curricular validity, three techniques were used.

(a) Test items to be included on the original test were determined by an analysis of the knowledge tests already available in this area, textbooks, and the minimum essentials set up as standards for teaching by the tennis committee of the Womens' Physical Education Department of the University of Washington.

(b) Everything covered in the test was included in the curriculum.

(c) The percentage of test items dealing with each phase of the activity agreed as much as possible with the emphasis placed on that particular phase in the course of study.

3. Item Validity

The item validity was found by the upper, lower thirds method. The test papers were divided into upper, middle and lower groups according to total score. Since there was a total of only 87 test papers, the 30 with the highest total scores were used as the upper third and the 30 with the lowest total scores were used as the lower third. The percentage of each group (upper and lower) who failed each item was calculated and the phi coefficient for the item determined.[1] The phi coefficient of each item was found in order to show whether or not the item as worded in the test was useful in discriminating between those who did well on the entire test and those who did poorly. For a group this size a coefficient of .3 was necessary to be acceptable at the 1 per cent level of confidence (to be sure that the item would discriminate in 99 cases out of 100).

[1] C. E. Jurgensen, "Table for Determining Phi Coefficients," *Psychometrika*, 12: 17–29, March, 1947.

II. Revised Test

Those questions with a phi coefficient of .3 and above on the original test were left as originally stated. The items which students had questioned or which showed a phi coefficient under .3 were revised. All these items were re-stated to include the same information in different words and often in a different question form.

A. Content and Question Type

The question types included on the revised test are as follows: Multiple True-False, Multiple Choice, True-False, Short Answer, Matching, and Identification. No attempt was made to place items dealing with certain phases of tennis into a specific question type as was done on the original test. For example: all test items dealing with rules were placed in a "yes-no" type of question on the original test. It was felt that the reliability and validity of certain items would be improved by placing them in another question type.

TABLE 1

Number and percentage of items devoted to each phase of tennis

PHASE	NUMBER	PER CENT
Equipment	3	2.3
Etiquette	4	3.1
History	6	4.7
Rules and Scoring	44	34.4
Strategy	19	14.8
Techniques	52	40.6
	128	99.9

A few questions concerning etiquette, rules and tournament play were added to the revised test, increasing the total number of items from 100 to 128. The Multiple True-False section replaced the Part I True-False section on the original test. Blanks were uniformly arranged on the right hand side of the paper for easy scoring. The number and percentage of items devoted to each phase of tennis in the revised test are presented in Table 1.

B. Statistical Analysis of Revised Test

1. Reliability

The reliability of the revised test was figured on 297 cases of beginning students and 46 intermediate students. It was computed by the same method as the original test which was by correlating the odd and even items (split-halves method) and correcting to actual length by the Spearman-Brown prediction formula. The reliability coefficient for the beginning classes was .82 $\pm$ .013, for the intermediate classes .92 $\pm$ .015, and for the combined beginning and intermediate classes .86 $\pm$ .009.

2. Validity

The item validity was computed only on the 297 tests taken by the beginning classes since there were too few cases for such a study in the intermediate group. The method for determining item validity was the same as that used on the original test. With 297 cases, the 88 (29.6%) papers with the highest total scores were used as the upper group and the 88 (29.6%) papers with the lowest total scores were used as the lower group. This percentage of the papers was selected since this was the point nearest 27% where a natural break in scores occurred. The percent of each of these groups who failed each item was calculated and the phi coefficient for the item determined. For a group this size a coefficient of .226 was necessary to be acceptable at the 1% level of confidence.

While on the original test approximately 30 items showed a high discrimination index (see appendix I), on the revised test approximately 70 items showed a high discrimination index. In addition about 20 other items on the revised test had a phi coefficient of .150 and above which would indicate that, with some revision, these would show acceptable discrimination. In several cases where these items did not discriminate the total difficulty of the item was low. These figures cannot be taken as final since classes taught by five different instructors were involved. In spite of previous agreement on the curriculum, three of the five instructors reported that they had not covered all of the material. This, of course, lowers curricular validity and at the same time definitely affects the discrimination results. For example: 68, 76, 77, 78, 93, 94, 95, 97, 103 were items which were not taught by some of the five instructors involved and, as shown by the table in the Appendix, these items have either a negative or very low phi coefficient. For seven items the phi coefficients were higher on the original test than on the revised test. This would indicate that changes which were made on the original test items were not satisfactory in these cases.

Table 2 shows the range of scores on the entire test for beginning and intermediate students. A comparison of the two distributions can be used as an indication of validity of the total test. It is evident that the intermediate students did better on the test than the beginning students. The beginning group was large enough that the scores should show a fairly normal distribution and Table 2 indicates that these scores do fall into a fairly normal distribution. The mean score for this group was 48.2[2] with a sigma of 12.5. The intermediate group was so small that a completely normal distribution could not be expected. One score is so far below the entire group that the sigma with this score included is 11.5, which is quite large. Without this score the mean for this group is 28.5 and the sigma is 8.8. The scores also indicate that the range was adequate to classify students, on the basis of

[2] Number of items missed.

knowledge, into A, B, C, D, E, groups and therefore the test was useful as a grading device.

III. Summary and Conclusions

The Comprehensive Knowledge Test has been found to satisfy most of the criteria for a good test.

The test is completely objective. It can be easily administered in 50 minutes. Since all blanks are uniformly arranged for easy scoring, it requires very little time to correct. The physical and technical make-up, language, and general construction satisfy the approved criteria for a good test.

TABLE 2

Range of scores on comprehensive knowledge test

NUMBER ITEMS MISSED	BEGINNING		INTERMEDIATE
13–17	1	4	4
18–22	3		8
23–27	17	35	8
28–32	18		15
33–37	30	66	4
38–42	36		1
43–47	38	87	3
48–52	49		2
53–57	43	74	
58–62	31		
63–67	14	23	
68–72	9		
73–77	6	8	1*
78–82	2		
	297		46

Beginning: Mean—48.2 Sigma—12.5
Intermediate: Mean—29.4 Sigma—11.5
* Without this one low score the mean for the intermediate group is 28.5 and the sigma is 8.8.

The reliability for the beginning group was found to be .82, for the intermediate group .92, and for the combined group .86. The percentage difficulty of individual questions ranged from 3.7 to 93.9 per cent. The range in total scores was from 13 to 82 for the entire group. A comparison of the two distributions indicates the validity of the test. Since the test showed a normal distribution of scores, it was possible to use it as a grading device.

When the test was constructed, it was felt that curricular validity would be satisfied since everything covered in the test was included in the curriculum; however, it was found that certain items were not taught by some of the instructors and that this affected both the curricular validity and the item validity. Curricular validity was satisfied to the extent that the percentage of test items dealing with each phase was agreed upon by the com-

mittee and corresponded, as much as possible, with emphasis placed on that particular phase during the course.

All items have not been shown to be highly valid and considerable more work needs to be done in the revision of some of these. However, 70 items on the revised test as compared with 30 items on the original test showed a high validity. In addition about 20 other items showed a nearly acceptable validity. As already pointed out, the validity of nine items was decreased by the fact that certain instructors did not teach some of the material outlined in the curriculum.

The test itself has been useful as a knowledge grading device since test scores have enabled the various instructors to classify students into A, B, C, D, E groups with ease. Procedures formulated in the construction of this test have served as a guide to grading committees in other activities in the construction of written examinations.

Forehand-Backhand Drive Test

I. Purpose

A constant need has been felt for an objective skill test which would help define the performance necessary for grades A, B, C, D, E and which might also serve to classify the students near the beginning of the term into beginning, intermediate, and advanced groups. The one tennis skill test which has been studied extensively is that constructed and reported by Joanna Dyer.[3] Since the Dyer Test gives one score as a measure of tennis ability in general it does not indicate in which primary area a student's weakness lies. While this test is on the whole administratively economical to conduct, its use with large numbers is limited by the availability of a tennis backboard or a fairly extensive free wall space.

The usefulness of available tests to measure skill in the forehand drive and backhand drive has been limited by inadequate statistical study on such tests. The primary purpose of this experimental study, therefore, was to determine, as far as possible, the effectiveness of an extremely simple objective skill test in tennis which could be used as a grading device as well as to point up relative weakness and strength in forehand and backhand drives.

Probably the greatest obstacle in setting up a valid and reliable tennis drive test has been the difficulty of putting the ball into play in such a way that every student would have an equal opportunity for success. A good ball throwing machine which can be set to toss balls within a certain specified small area is the best answer. Every school cannot afford the luxury of such equipment, but the problem of grading is always present.

In an attempt to find some grading device which would be objective, which would do away with the necessity of tossing the ball to the student, and which would be easily as well as quickly administered, the following test was tried.

[3] Joanna Thayer Dyer, "Revision of the Backboard Test of Tennis Ability," *Research Quarterly*, **9**(1): 25-31, March, 1938.

II. Subjects

The subjects for this study were a group of 59 beginning and intermediate tennis players. Group I consisted of 27 students participating in an intermediate tennis class and Group II consisted of 32 students in a beginning tennis class.

III. Description of Test

The test was designed to measure students' ability to place forehand and backhand drives into the backcourt area. It consisted of hitting a given number of balls so that they would pass between the top of the net and a restraining rope placed above the net, and of attempting to place these balls into the back 9 feet of the court. The ball was put into play by the student bouncing the ball to herself.

A. Equipment

1. One regulation court.
2. One regulation net with a rope stretched 4 feet above the top of the net. *Note:* The most effective drives are those that are hit with a good deal of force into the backcourt. This restraining rope is a device to measure, to a degree, the force of the drive. A ball passing between the net and this restraining rope and landing in the backcourt area must have been hit with more force than a ball going high (over the rope) and landing in the same area. Driver constructed a tennis test which made use of the restraining rope placed 7 feet above the top of the net.[4] However, during experimentation it was observed that a restraining rope placed that high did not discriminate between players of varying ability; i.e., it was possible for a player to hit balls slowly and with little force 7 feet high and have them hit in the backcourt and therefore score as high as a player who hit fast low drives.
3. One racket and 15–20 balls in good condition.
4. Score sheets for each player (see Figure I) and pencils.
5. Special court markings (see Figure II).
   a. Two chalk lines drawn across the court 10 feet inside the service line and 9 feet outside the service line and parallel to it.
   b. Two chalk lines drawn across the court 5 feet and 10 feet respectively outside the baseline and parallel to it.
   c. Chalked numbers in the center of each area to indicate its scoring value.

B. Test

1. The player taking the test stands behind the baseline, bounces the balls to herself, hits the balls and attempts to place them in in the back 9 feet of the opposite court.
2. Each player is allowed fourteen trials on the forehand and fourteen trials on the backhand.

[4] Helen Irene Driver, *Tennis for Teachers*, Phila., Penn.: W. B. Saunders Co., 1941, p. 163.

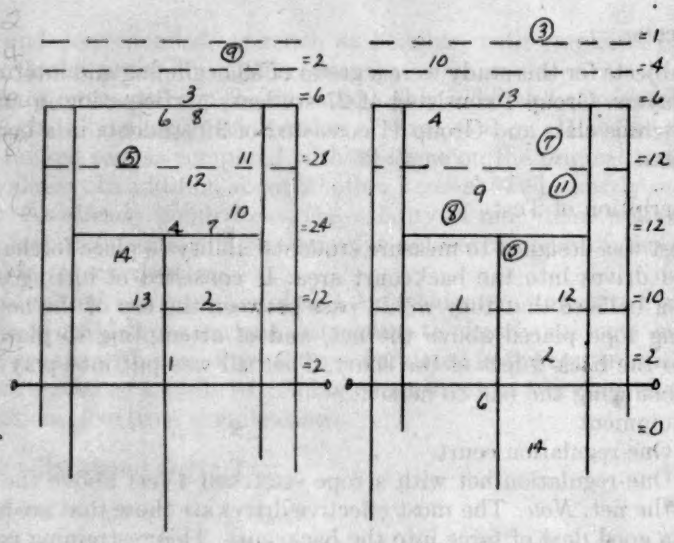

FIGURE I. Completed score card for forehand-backhand drives

The trial number is marked in the same relative position on the score card as the ball lands on the court. The circle around the number indicates that the ball went over the restraining rope and therefore receives only half the scoring value of the area in which it hits.

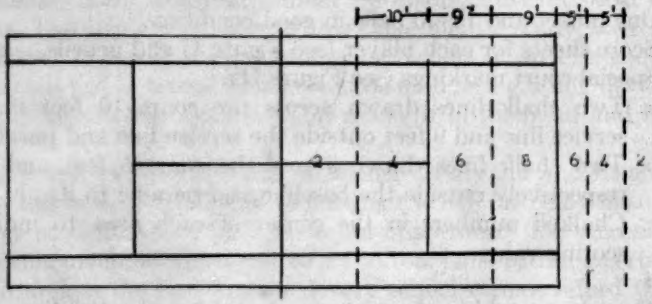

FIGURE II. Special court markings for forehand-backhand drive test

3. In order to score the values as shown on Figure II, balls must go between the top of the net and the rope and land in the designated area or on lines bounding the area (balls landing on a line receive the highest score for that area).

4. Balls which go over the rope score one-half the value of that area in which they land.
5. If the player misses the ball in attempting to strike it, it is considered a trial.
6. Let balls are taken over.

C. Scoring[5]

1. The number of each trial is marked on the score card diagram in the same relative position as the ball landed on the court. (See Figure I).
2. Each ball hit is scored 2-4-6-8-6-4-2, depending upon the area in which it lands. *Note:* Each ball going over the rope is scored one-half the value of the area in which it lands (this may be indicated by circling the ball number on the scoring diagram).
3. The total score equals the sum of fourteen balls on the forehand and fourteen balls on the backhand.

IV. Statistical Analysis

A. Reliability

The reliability of the test was computed by correlating the total score of the first 7 balls on the forehand plus the first 7 balls on the backhand with the total score of the second 7 balls on the forehand plus the second 7 balls on the backhand and predicting[6] the validity of a test twice as long. The reliability for the beginning group was shown to be .80 $\pm$ .047, and for the intermediate group was shown to be .80 $\pm$ .043.

B. Validity

It was decided that, prior to the student's taking the test, the instructor and other judges, who were qualified tennis instructors, would make comparative ratings of the student's ability according to certain standards set up by the Tennis Grading Committee. The purpose of this procedure was to validate the test as a method of grading form on the forehand and backhand drives. These subjective ratings given to the students by the instructor teaching the class and by the other selected judges were used as the criteria. In the intermediate group (Group I) ratings were given by the instructor and one judge. In the beginning group (Group II) ratings were given by the instructor and two other judges.

The validity of the test was computed by correlating the ratings given to the student by the various judges with the students' performance on the test. In Group I (intermediate) the correlation of the two judges' combined subjective rating with the test was .85. The correlation between

[5] Since the test was designed to measure the ability to place the drives in the back court, it was necessary to give some scoring value to those areas which are just outside the desired area. Trials which hit a few feet beyond the back 9 feet of the court should not be penalized any more than those which hit a few feet short—even though those which are short hit within the court.

[6] Spearman-Brown Prophecy Formula.

the instructor's subjective rating of the student and the test was .87 while the correlation between the subjective rating made by Judge 2 and the test was .74. The subjective ratings of these two judges showed a correlation of .83 (See Table 3).

In Group II (beginning) the correlation between the combined subjective rating of the three judges and the test was .61. The correlation between the instructor's subjective rating and the test was .66. The correlations of the subjective ratings made by Judges 2 and 3 with the test were .47 and .46, respectively. The subjective ratings of these three judges varied greatly as shown by intercorrelations of .56, .58, and .35 (see Table 4).

TABLE 3*

Correlation of subjective ratings and test scores on forehand-backhand drive test

JUDGES	JUDGE 2	TEST SCORE
Judge 1 (Instructor)	.82	.87
Judge 2		.74
Average of Judges 1-2		.85

* Group I (Intermediate). Results obtained on 27 college women in the intermediate tennis class.

TABLE 4*

Correlation of subjective ratings and test scores on forehand-backhand drive test

JUDGES	JUDGE 2	JUDGE 3	TEST SCORE
Judge 1 (Instructor)	.56	.58	.66
Judge 2		.35	.47
Judge 3			.46
Average of 1-2-3			.61

* Group II (Beginning). Results obtained on 32 college women in the beginning tennis class.

Lower correlations are to be expected with beginning groups due to the fact that beginners are less consistent. This also partially accounts for the higher validity correlation between the test score and the subjective judgment of the instructor of the class who was well acquainted with their abilities. The judgment of the other tennis instructors was based on one day's observation only.

V. Summary and Conclusions

The results of this test are based on very small groups and can, therefore, only be taken as indications.

The test as constructed here with fourteen trials of each drive (forehand and backhand) seems to be fairly reliable.

The test seems to be more valid for the intermediate group than for the beginning group since the validity coefficients obtained by correlations

between the judges' subjective ratings of the students and the results of the test were very low for the beginning group and acceptable for the intermediate group. However, the ratings of Judge 1, who was the instructor of the class, agree more nearly with the test scores than with the subjective ratings of either of the other judges for the beginning group. Judges 2 and 3 agreed more with Judge 1 (instructor) than with the test scores but less with each other than with the test scores. The agreement between subjective ratings and the test is, in general, higher than the agreement between the subjective ratings of the various judges grading the classes. Therefore, the test can be said to be an improvement over the judgment of qualified tennis instructors as a means of grading forehand and backhand form. The validity correlations are high enough, particularly between the instructor's subjective judgment and the results of the test, to warrant more intensive investigation.

It was found that approximately 30 students can be tested in one hour with one instructor recording. It would be very possible to teach the students to record for each other and the testing time would then be negligible.

The test shows promise of being a practical and useful objective grading as well as a classifying device.

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APPENDIX I

Difficulty and item validity ratings
Knowledge Examination

N_2	%D	%1	%2	PC_1	PC_2
1	7.1	3.4	13.6	0	.197
2	9.8	11.4	*11.4	.450*	0
3	5.4	3.4	9.1		.126
4	5.4	1.1	3.4	−.033	.071
5	8.4	6.8	12.5		.085
6	23.2	20.5	34.1		.158
7	21.2	11.4	30.7		.246*
8	28.6	20.5	44.3		.257*
9	9.1	9.1	12.5	.333*	.049
10	14.5	3.4	12.5	.264	.171
11	44.4	23.9	63.6		.403*
12	16.2	4.5	25.0	.130	.298*
13	26.9	18.2	38.6	−.050	.220*
14	8.1	5.7	11.4	.229	.090
15	6.1	3.4	12.5	−.184	.171
16	53.9	45.5	71.6	.551*	.700*
17	37.7	32.9	50.0	0	.173
18	74.7	62.5	77.3		.163
19	13.5	10.2	17.0	.277	.102
20	55.9	48.9	55.7		.060
21	3.7	2.4	10.2	.154	.168
22	58.9	50.0	64.8		.152
23	25.3	9.1	40.9	−.073	.370*
24	52.9	39.8	65.9		.260*
25	50.2	40.9	61.4		.200
26	12.8	10.2	18.2	0	.115
27	40.7	42.0	39.8	.131	−.020
28	20.9	15.9	28.4	.229	.145
29	17.8	17.0	26.1	.039	.110
30	18.2	18.2	22.7	.075	.062
31	19.2	22.7	18.2	−.158	−.049
32	29.3	28.4	34.1	.143	.065
33	26.3	22.7	30.7		.090
34	55.6*	35.2	80.7	.309	.466*
35	46.8	45.5	54.5	−.153	.080
36	26.9	17.0	33.0	.325	.185
37	25.9	12.5	44.3		.356*
38	13.1	3.4	28.4		.345*
39	47.8	39.8	56.8		.170
40	54.2	26.1	80.7		.551*
41	82.5	71.6	93.2		.276*
42	65.7	40.9	87.5	.271	.499*
43	53.5	10.2	79.5		.694*
44	52.2	18.2	84.1	.286	.660*
45	49.8	13.6	86.4	.219	.720*
46	65.0	50.0	93.2	.184	.476*
47	8.8	4.5	10.2	0	.118
48	15.5	13.6	19.3		.067
49	5.1	2.4	4.5		.059
50	17.5	6.8	12.5		.085

* Items discriminating at the 1% Level of Confidence.
N_2 Number of item on revised test.
%D Per cent of people missing item.
%1 Per cent of upper group missing item.
%2 Per cent of lower group missing item.
PC_1 Phi coefficient of each item (discrimination rating) on original test.
PC_2 Phi coefficient of each item on revised test.

APPENDIX I—*Continued*

Difficulty and item validity ratings—Continued

N_2	%D	%1	%2	PC_1	PC_2
51	14.1	5.7		.140	.185
52	12.8	14.8	14.8		0
53	3.7	0	5.7	−.056	.176
54	6.7	2.4	11.4		.183
55	34.3	30.7	37.5	.280	.074
56	26.6	17.0	35.2	.143	.205
57	7.4	2.4	14.8	.115	.233*
58	46.5	37.5	53.4	.229	.161
59	5.1	3.4	4.5		.051
60	5.4	1.1	13.6		.247*
61	32.0	27.3	34.1		.076
62	13.5	4.5	28.4		.327*
63	33.7	23.9	49.9	.336*	.260*
64	47.5	19.3	77.3	.389*	.580*
65	47.5	26.1	70.5	.362*	.440*
66	50.5	25.0	78.4	.634*	.540*
67	53,2	43.2	64.8	.105	.221*
68	93.9	95.5	94.5	.241	−.022
69	42.4	10.2	76.1	.312	.667*
70	19.5	3.4	28.4	.264	.345*
71	25.6	17.0	28.4		.132
72	41.4	20.5	64.8	.173	.455*
73	40.7	18.2	62.5	−.092	.496*
74	37.0	13.7	56.8	.154	.449*
75	46.1	17.0	83.0	.297	.660*
76	37.0	29.5	42.0	.430*	.125
77	65.6	65.9	72.7	.370*	.076
78	33.3	40.9	29.5	.601*	−.125
79	10.4	3.4	20.5	.476*	.277*
80	21.2	12.5	25.0	.488*	.153
81	42.8	37.5	48.9	.436*	.121
82	58.2	40.9	73.9	.300	.334*
83	20.5	10.2	34.1	.283	.290*
84	43.4	38.7	52.3	.389*	.131
85	17.8	11.3	30.7	0	.246*
86	16.5	7.9	23.9	.140	.218
87	19.5	11.3	29.5		.235*
88	42.1	28.4	58.0	.125	.303*
89	6.7	2.4	14.8	.229	.233*
90	40.0	28.4	54.5	.056	.264*
91	59.2	52.3	75.0	.138	.239*
92	18.5	13.7	28.4	.190	.172
93	50.2	50.0	50.0	.266	0
94	46.5	42.0	47.7		.060
95	33.0	29.5	35.5	.207	.085
96	80.1	56.8	95.5	.173	.453*
97	5.1	6.8	8.0	.264	.019
98	76.8	59.1	95.5	.488*	.428*
99	48.5	14.8	81.8	.606*	.670*
100	85.6	68.2	95.5	.343*	.364*
101	26.3	20.5	30.7	.266	.114
102	26.0	21.6	40.9	.266	.205
103	92.9	94.3	95.5	.241	.046
104	26.9	13.7	44.3	.280	.331*
105	59.9	48.9	70.5	.305	.225*
106	30.0	10.2	56.8		.498*
107	78.1	51.1	98.9		.554*
108	78.5	55.7	96.6		.483*

APPENDIX I—*Continued*

Difficulty and item validity ratings—Concluded

N_2	%D	%1	%2	PC_1	PC_2
109	64.0	42.0	92.0	.474*	.532*
110	30.0	8.0	54.5	.532*	.506*
111	50.2	30.7	69.3	.515*	.380*
112	54.6	28.4	84.1	.471*	.564*
113	42.8	30.7	68.2	.531*	.370*
114	78.1	56.8	97.7	.219	.491*
115	60.6	34.1	83.0	.297	.497*
116	63.0	40.9	87.5	.390*	.467*
117	79.8	63.6	88.6	.173	.267*
118	26.3	4.5	47.7	.589*	.487*
119	51.9	39.8	74.0	.074	.354*
120	31.0	9.1	52.3	.047	.467*
121	33.7	17.0	61.4	.425*	.451*
122	12.1	1.1	26.1	−.074	.366*
123	21.9	18.2	38.7	.362*	.233*
124	6.4	2.4	14.8	.395*	.233*
125	41.8	20.5	54.5	−.074	.350*
126	76.1	48.9	94.3	.503*	.498*
127	60.3	26.1	88.6	.461*	.637*
128	64.3	35.2	79.8	.578*	.568*

APPENDIX II

Comprehensive Tennis Examination

University of Washington

Name.....

Instructor.....

Answer all questions as for right-handed players.

Score Summary

1. Multiple True-False .....
2. Multiple Choice .....
3. True-False .....
4. Identification .....
5. Completion .....
6. Matching .....
7. Identification .....

Total .....

Part I. Multiple True-False: If the statement is entirely correct, encircle the "T." If the statement is totally or partially incorrect, encircle the "F."

A. Loss of force in a forehand drive stroke results from
1. transferring the weight from the rear foot to the foreward foot..... T F
2. using a long backswing..... T F
3. holding the elbow close to the body..... T F

B. When using the Eastern forehand grip
4. the player shakes hands with the racquet..... T F
5. the same racquet face contacts the ball on the forehand and backhand drives..... T F
6. the thumb curves around the handle of the racquet..... T F
7. the forefinger is extended directly up the handle of the racquet..... T F
8. the racquet face should be perpendicular to the ground when the player grasps the racquet..... T F

C. At the moment of impact with the ball
9. the racquet should be held loosely..... T F
10. the racquet head should be lower than the wrist..... T F
11. the racquet face should be closed..... T F

D. In order to insure proper timing a player should
12. wait until the ball bounces before moving into position for the stroke. T F
13. take the backswing while moving into position. T F
14. keep weight on her heels. T F
15. attempt to get in the direct path of the ball. T F

E. Putting top spin on the ball
16. increases the speed of the ball. T F
17. makes the ball stay in the air longer. T F
18. makes the ball bounce low. T F

F. In serving, the ball should be
19. tossed as the racquet begins to swing down and back. T F
20. released when the hand is approximately at shoulder level. T F
21. hit with the racquet arm fully extended. T F
22. hit above the right shoulder. T F

G. When executing a volley stroke
23. a shortened swing should be used. T F
24. the elbow is extended throughout the stroke. T F
25. the ball should be met well in front of the body. T F

H. In executing the forehand drive
26. the follow-through should be in the direction of the intended ball flight. T F
27. one should attempt to hit the ball when it is in line with the left foot. T F
28. one should face the right alley. T F
29. one should attempt to play the ball when it is waist high. T F

I. In executing the backhand drive
30. the palm of the racquet hand should be facing the ground with the thumb extended along the left side of the handle. T F
31. the right shoulder should point toward the left alley at full backswing T F
32. the racquet should lead the arm on the forward swing. T F
33. the left foot should be nearer the alley than the right foot. T F

J. In executing a drive, a beginner should
34. stroke the ball on the rise or as soon after the bounce as possible. T F
35. look at the spot where she wants to place the ball. T F
36. strive to get height in the ball flight in order to send drives to the back court. T F

K. Lobs should
37. be made only at the net. T F
38. be used to force the opponent from a position near the net. T F
39. have a backswing which looks like a drive backswing except that it is slightly shorter. T F

L. In the American twist service
40. the racquet contacts the ball behind the head. T F
41. the follow-through is near the left ankle. T F
42. the bounce of the served ball is high. T F
43. the ball is given top and side spin. T F

M. In the early history of tennis
44. the tennis court resembled an hourglass. T F
45. the ball was played with the hand. T F
46. the balls were made of canvas. T F

N. A footfault occurs when the server, while in the act of serving
47. changes position by walking. T F
48. steps on the baseline after her racquet strikes the ball. T F
49. jumps with both feet off the ground before the racquet strikes the ball. T F
50. takes one foot off the ground before the racquet strikes the ball. T F

O. It is good strategy to
51. develop a change of pace in strokes ..... T F
52. go to the net when the opponent is at the net ..... T F
53. play to the opponent's weakness ..... T F
54. avoid using the backhand stroke ..... T F

P. A player loses the point if
55. she is standing behind the baseline and catches a ball before it bounces ..... T F
56. she reaches over the net to strike an oncoming ball but doesn't touch the net ..... T F
57. she hits the ball on her side of the net and allows her racquet to swing across the net on the follow-through without touching the net ..... T F
58. as she makes a good return, the racquet slips from her hands and falls into the opponent's court ..... T F

Q. It is considered good tennis etiquette
59. in the absence of an umpire, for the server to call the score before serving ..... T F
60. to recover balls from another court, where play is in progress, by running on that court and getting the ball out of the way quickly ..... T F
61. for a spectator to applaud good strokes as they occur during the rally. T F
62. to question the umpire if one disapproves of her decision ..... T F

Part II. Multiple Choice: Place a figure X opposite the statement which best applies to the particular situation.

63. When serving in singles the server should stand behind the baseline
a. halfway between the center mark and the singles side line ..... ( )
b. near the singles side line ..... ( )
c. near the center mark ..... ( )
d. behind the alley ..... ( )

64. While rallying, doubles players should assume a court position in which
a. partners are diagonally opposite each other ..... ( )
b. partners are directly behind each other ..... ( )
c. partners are parallel to each other ..... ( )
d. one player covers half the net and her partner covers the entire backcourt ..... ( )

65. In singles, after each stroke made near the baseline, the player should assume a position
a. between the service line and baseline ..... ( )
b. behind the center of the baseline ..... ( )
c. near the net ..... ( )
d. behind the baseline where the last stroke was made ..... ( )

66. When playing defensively a player should stand
a. between the service line and the baseline ..... ( )
b. near the net ..... ( )
c. behind the baseline ..... ( )
d. on the service line ..... ( )

67. If a player swings at a ball before it bounces but misses it and the ball lands outside the court
a. she wins the point ..... ( )
b. she is considered as having played the ball ..... ( )
c. her opponent wins the point ..... ( )
d. the point is played again ..... ( )

68. In a women's match a rest period may be taken
a. after the first set ..... ( )
b. any time ..... ( )

c. after second set ( )
d. at a time agreed upon by both players ( )

69. Net position is considered the position for
a. drive strokes ( )
b. defense play ( )
c. lob strokes ( )
d. offense play ( )

70. A set is completed
a. when the server has 6 games and the receiver has 5 games ( )
b. when the server has 4 games and the receiver has 2 games ( )
c. when the server has 7 games and the receiver has 6 games ( )
d. when the server has 6 games and the receiver has 4 games ( )

Part III. True-False: If the statement is entirely correct, encircle the "T." If the statement is totally or partially incorrect, encircle the "F."

71. In singles a player should advance to the net when her opponent is using a backhand stroke T F
72. Advanced doubles is primarily a baseline game T F
73. Ash is considered the best quality of wood for tennis racquets T F
74. Lambs' gut is considered the best quality of gut for stringing racquets T F
75. The first game resembling our modern game of tennis came from Ireland. T F
76. If a player wins the toss, she must serve first T F
77. A player may serve underhand T F
78. The ball may be played by holding the racquet in both hands T F
79. When both sides have won three points the score is "thirty all" T F
80. It is necessary for the receiver of the service to stand in the court T F
81. The score is "games-all" when both sides have won 4 games T F
82. For a block volley, a player should stand about two feet behind the service court line T F
83. If a let is called in the middle of a rally, the server is entitled to serve two more balls even though the first ball served was a fault T F
84. The overhead smash is best executed from the backcourt T F
85. After serving a fault the second ball should be served with very little force T F

Part IV. Which of the following situations would give a point to the server, a fault to the server, or a let to the server? Encircle "P" for point, "F" for fault, and "L" for let.

86. While serving, the server misses the ball in attempting to strike it P F L
87. A served ball touches the receiver before it touches the ground P F L
88. The server wins the rally, then discovers her partner should be serving P F L
89. A served ball hits on the line between the receiver's right and left service courts and is not returned P F L
90. The server wins the rally then discovers she served from the wrong court P F L
91. While standing behind the ally, the server in a singles game served into the proper service court and the receiver fails to return the ball P F L
92. The server hits the first ball into the net and the second ball goes out-of-bounds P F L
93. The receiver returns a served ball for which she claims she was not ready and the returned ball goes out of the court P F L
94. The served ball hits the receiver's partner before it touches the ground P F L
95. The served ball strikes another ball which has rolled into the receiver's service court P F L

Part V. Completion: Answer the following questions in one or two words.

96. Which is the most effective stroke in doubles play? .....
97. Which player's score is called first? .....

98. What is the name of the cup presented to the winner of the competition between women in the U. S. and England?.....
99. What is the name of the cup presented to the winner of the international competition event for men only?.....
100. What type of surface on a court plays the ball faster than any other type?.....
101. What is the maximum number of sets in a match for women?.....
102. What is the score when the server has won one point after deuce?.....
103. What is the maximum number of minutes allowed for the rest period in a women's match?.....
104. If, during the service, a served ball touches the top of the net and goes into the proper court, what is this ball called?.....
105. When should players change sides of the net?.....
106. In the absence of an umpire who should determine whether or not the service is good?.....
107. What has a player, who does not have to play the first round of a tournament but who is immediately advanced to the 2nd round, received?.....
108. What is the loser in the final round of a tournament called?.....

Part VI. Matching: The descriptions in Column II apply to some of the words or phrases in Column I. Place the appropriate letter from Column I in the blanks provided in Column II.

Column I

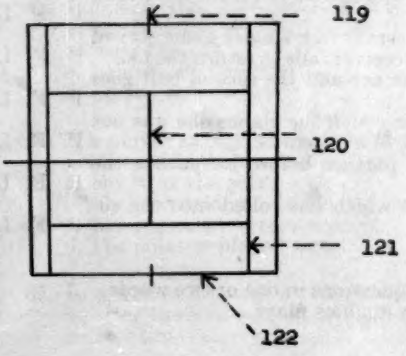
A. angled shot
B. American twist
C. cannon ball
D. chop
E. drop shot
F. half volley
G. lob
H. side spin
I. slice
J. smash
K. stop or block volley
L. top spin
M. volley

Column II

109. A stroke which produces back spin on the ball.....
110. A stroke made by hitting the ball before it touches the ground.....
111. An effect which is produced by drawing the racquet strings over the top of the ball as it is struck.....
112. A stroke made by hitting the ball just after it bounces off the ground.....
113. A stroke used to return a lob and which resembles the service stroke.....
114. A stroke which causes the ball to bounce low to the left.....
115. A stroke in which the racquet meets the ball and does not follow through.....
116. A flat hard service.....
117. A stroke which gives excessive spin to the ball and causes it to bounce in a high arc.....
118. A stroke which lofts the ball above and beyond the reach of opponent at the net.....

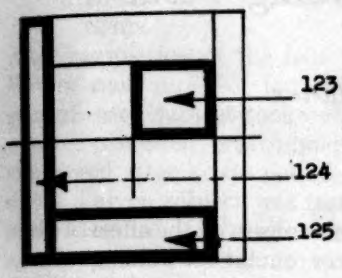
Part VII. Identification

A. Give the official names of the *lines* of the court that are numbered in the diagram by placing the name in the blank provided.



119. .....
120. .....
121. .....
122. .....

B. Give the official names of the *spaces* of the court that are numbered in the diagram by placing the name in the blank provided.

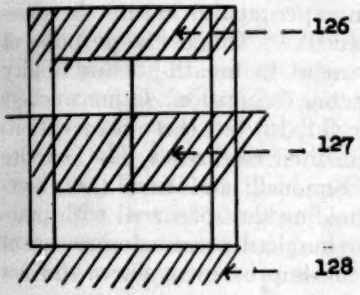


123. .....

124. .....

125. .....

C. Name in terms of strategy the shaded *zones* that are numbered in the diagram by placing the name in the blank provided.



126. .....

127. .....

128. .....

An Analysis of Breath-Holding Tests

HENRY J. MONTOYE*
School of Physical Education
University of Illinois

NUMEROUS investigators have observed the effect of physical conditioning, diet, or some other factor on breath-holding ability. Despite the lack of adequate controls in many of these studies (2, 5, 7, 12, 13, 15, 19), the change (or lack of change) in breath-holding time was attributed to the effect (or lack of effect) of the experimental factor. In certain other breath-holding studies of an experimental nature the presence or absence of controls was not specified (6, 9). One of the purposes of this study was to determine the improvement in breath-holding ability which may be expected merely through practice (repetition). Other workers have noticed that improvement does occur (11, 16) but these observations were incidental to the principal problems in their researches. The practice effects themselves were not investigated. Simonelli and Ferri (18), however, plotted the improvement in breath-holding that occurred with practice. In their few subjects they secured one hundred percent improvement after only a few weeks. In one subject, the improvement curve did not show signs of leveling off even after 23 trials.

A second purpose in carrying out this project was to determine to what degree breath-holding times are affected by the duration of moderate exercise taken immediately before the breath-holding tests. The effect of intensity of exercise preceding breath-holding has been reported by Rodbard (14). He observed that the length of time the breath was held was indirectly proportional to the number of footpounds of work performed in fifteen seconds on a bicycle ergometer. The effect of the duration of exercise apparently has not been studied.

Procedure

The group of subjects comprised twenty-two college men all of whom were physical education majors. None, however, was a member of a varsity team. All were secured on a volunteer basis. The sample is probably representative within these limits.

The battery of breath-holding tests included the following:

1. Normal breath-holding (i.e., not preceded by exercise).
2. Breath-holding after one minute of stepping up on to a seventeen inch bench at the rate of thirty steps per minute.

* Now at Michigan State College. The data were secured in the Physical Fitness Research Laboratory, School of Physical Education, University of Illinois.

3. Breath-holding after two minutes of stepping (same bench and tempo).
4. Breath-holding after five minutes of stepping (same bench and tempo).

After completion of the four tests the battery was repeated twice more. Within each series of four tests the order of selection was random. In general, each subject took only one test per day. However, in some cases when the normal breath-holding test was taken, a second test was administered after a rest period of twenty minutes. The time of the day at which a given subject was tested did not vary more than thirty-five minutes. Most of the subjects completed the twelve breath-holding tests within a period of two weeks, although in some cases the testing was distributed over a three week period. If the subject appeared to be definitely affected by a cold or other ailment, the testing was postponed until a later date.[1]

The details of administering the breath-holding tests were as follows:

1. Before beginning each test, the subject was allowed to practice holding his breath a few times for very brief periods in order to become adjusted to the apparatus.
2. A nose clip was used during all tests.
3. Three deep breaths were allowed before beginning the hold, i.e., the breath was held at the end of the third inhalation. Karpovich (8) secured a higher coefficient of reliability using this method as compared to taking only one breath.
4. For the purpose of standardizing intrathoracic pressure the breath was held on the flarimeter (20) with both orifices closed and the water level maintained at the equivalent of 20 mm. Hg pressure. Despite continuous urging on the part of the testor, the water level fluctuated considerably during the last stages of the hold.
5. The tempo during the stepping exercise was maintained by an electric metronome.
6. The time of the hold, to the closest tenth of a second, was measured with the aid of a stop watch.
7. All of the tests were administered by the writer and every effort was made to motivate each subject to go "all-out" on every trial.
8. The subjects were instructed not to practice breath-holding except at the time tests were given.

Results

A summary of the breath-holding data is presented in Table 1. All of the distributions of scores were unimodal and slightly positively skewed. Graph I shows the improvement in breath-holding ability that occurs

[1] Inasmuch as there was positive pressure in the breathing circuit special care was taken not to administer the test to a subject with a head cold to avoid the possibility of spreading the infection to the ears via the eustachian tubes. Also, Henry (4) reported that colds decrease breath-holding time.

with practice. The effect on breath-holding time of variations in the duration of exercise immediately preceding the test is illustrated in Graph II.

In an effort to determine whether or not the improvement in breath-holding was significant and also whether the duration of exercise preceding the test significantly affected the breath-holding times, the analysis of variance technique was applied to test the means for homogeneity. However, this method, as also the small sample "t" test, involves the assumption of equality of variance among the distributions if the differences between groups are to be attributed to differences in means. In order to

TABLE 1

Mean, standard deviation, and range of each distribution of breath-holding scores

TYPE OF BREATH-HOLDING TEST	MEAN	σ	RANGE	N
	secs.	secs.	secs.	
Normal breath-holding (no exercise)				
First trial	82.7	36.1	37–182	22
Second trial	100.5	36.0	60–188	22
Third trial	116.6	36.5	53–200	22
Best score	119.1	34.1	72–200	22
Breath-holding after 1 min. stepping				
First trial	25.2	11.4	9–51	22
Second trial	36.9	19.4	15–110	22
Third trial	43.5	22.2	12–112	22
Best score	46.1	20.7	15–112	22
Breath-holding after 2 min. stepping				
First trial	24.7	14.7	11–63	22
Second trial	31.3	18.0	13–74	22
Third trial	37.8	15.0	11–69	22
Best score	40.6	15.8	14–74	22
Breath-holding after 5 min. stepping				
First trial	27.0	17.1	10–80	22
Second trial	32.2	16.7	11–75	22
Third trial	37.4	17.7	13–95	22
Best score	39.7	16.9	13–95	22

ascertain whether or not this assumption was a reasonable one, the F-ratio test was applied to the sixty-six variance combinations. This test indicated that the differences in variability *among* the distributions of normal breath-holding scores and also *among* the distributions of exercise breath-holding times were insignificant.[2] The differences in variance *between* the normal and exercise breath-holding scores, however, were signifi-

[2] This does not prove that a true difference in variance does not exist but indicates, at least, that the error due to this assumption would probably not appreciably affect the results.

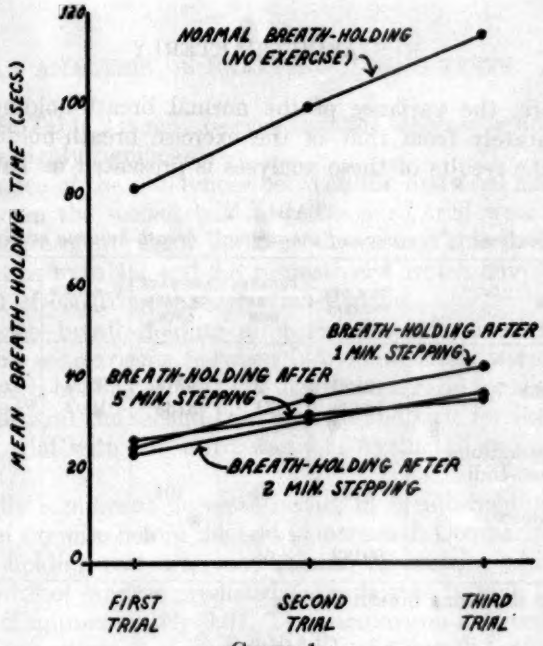


CHART 1

Effect of practice on breath-holding time
(N = 22)

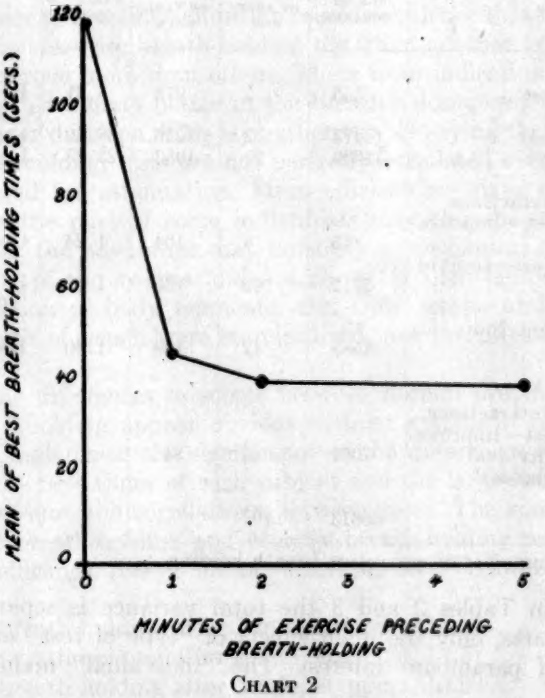


CHART 2

Effect of the duration of preceding exercise on breath-holding time
(N = 22)

cant. Therefore, the variance of the normal breath-holding scores was analyzed separately from that of the exercise breath-holding scores. A summary of the results of these analyses is presented in Tables 2 and 3.

TABLE 2

Analysis of variance of the normal breath-holding scores*

ITEM	SUM OF SQUARES	DEGREES OF FREEDOM	ESTIMATE OF VARIANCE	VARIANCE RATIO	PROBABILITY
Main Effects					
Improvement	12623	2	6312	32.5	Less than 0.001
Individual	78428	21	3735	19.2	Less than 0.001
First Order Interactions					
Improvement-Individual	8131	42	194		
(Error Variance)					
Total	99182	65			

* No exercise preceding breath-holding.

TABLE 3

Analysis of variance of exercise breath-holding scores*

ITEM	SUM OF SQUARES	DEGREES OF FREEDOM	ESTIMATE OF VARIANCE	VARIANCE RATIO	PROBABILITY
Main Effects					
Type of Test	555	2	278	3.31	Between 0.05 and 0.01
Improvement	6473	2	3236	38.52	Less than 0.001
Individual	41009	21	1953	23.25	Less than 0.001
First Order Interactions					
Type of Test—Improvement	415	4	104	1.24	Greater than 0.20
Type of Test—Individual	5712	42	136	1.62	Between 0.05 and 0.01
Improvement-Individual	4588	42	109	1.30	Between 0.10 and 0.20
Second Order Interactions					
Type of Test—Improvement-Individual	7061	84	84		
(Error Variance)					
Total	65813	197			

* Exercise immediately preceding breath-holding.

Although in Tables 2 and 3 the total variance is separated into its component parts, only the main effects of "type of test" and "improvement" are of paramount interest. The "individual" main effects refer

to reliability. In Table 2 it may be seen that the increase in normal breath-holding time is highly significant.

The significance of the differences between the first trial and the second trial and between the second trial and the third trial were investigated using the estimate of the error variance shown in Table 2. The resulting significance ratios were 4.2 and 3.8 respectively, which have probabilities less than 0.001 of occurring through chance alone.

Similarly, with breath-holding after exercise, improvement is highly significant. The comparisons between individual trials were made as in the normal breath-holding scores. The significance ratio for the comparison of the first trial with the second trial was 4.0 and that for the comparison of the second trial with the third was 4.1. Again the probabilities were less than 0.001.

A statistically significant decrease occurs in breath-holding time when the duration of exercise before the test is increased. Comparing the results of the breath-holding test after one minute of exercise with the results after two minutes of exercise produced a significance ratio of 2.5 which has a probability of approximately 0.01. The comparison between the breath-holding after two minutes of stepping with the breath-holding after five minutes of stepping resulted in a significance ratio of 0.59, which has a probability between 0.27 and 0.31.

The first order interactions afford no reliable evidence that improvement is greater in one exercise breath-holding test than another or that certain individuals improve more than others. There is an indication that certain subjects perform *relatively* better in the breath-holding tests preceded by exercise of longer duration. This is another way of saying that the various exercise breath-holding tests are not perfectly correlated even when completely corrected for attenuation. More efficient circulatory adjustment to exercise on the part of some individuals may thus be indicated. On the other hand, the advantage may be solely a mechanical one since the standardization of the exercise did not allow for such factors as weight, height, proportion of body segments, etc. Only tempo and duration of work and height of bench were standardized, not the physiological work done.

Although the differences in scores between normal breath-holding and exercise breath-holding appear obvious without statistical treatment, for the sake of completeness the significance of the differences in means was tested using the best times of each subject and the large sample method, taking into account the correlations between tests. The comparisons between normal breath-holding and exercise breath-holding resulted in the following significance ratios, all of which have probabilities less than 0.001:

1. With breath-holding after 1 min. stepping, 13.25
2. With breath-holding after 2 min. stepping, 13.57
3. With breath-holding after 5 min. stepping, 15.93

Discussion

Improvement in breath-holding of roughly fifty percent in raw scores was secured with a moderate amount of practice. When changes in breath-holding are being investigated, the need for adequate controls or practice until a plateau is reached is thus clearly indicated. Also, the ratio of the standard deviation to the mean in the distributions of breath-holding times (coefficient of variation) was quite high. This explains the difficulty encountered in demonstrating significant differences in studies of breath-holding ability.

The effect of decreasing breath-holding times by increasing the duration of moderate exercise preceding the breath-holding tests was not nearly as pronounced as the effect secured by Rodbard (14) by increasing the intensity of exercise (footpounds of work performed in fifteen seconds). Very likely during the first minute of stepping, an appreciable oxygen debt is formed and the breath-holding times are greatly reduced from normal. As the moderate exercise continues the circulatory system adjusts to the task and the oxygen debt is then accumulated at a much slower rate or not at all. However, when the *intensity* of the exercise is increased, an oxygen debt may continue to accumulate very rapidly even though circulatory adjustments are made.

One other observation should be described. Four of the twenty-two subjects reported that after the breath was held a certain period of time, "it became easy." These four cases had breath-holding scores far superior to those of the other subjects, which fact may account for the skewness in the distribution of scores. There were also objective signs of the lack of distress after the breath was held beyond the "hump," so to speak. One such indication was the water level in the flarimeter which became very steady although just previously it had fluctuated greatly. Furthermore, practically all respiratory movements and tremors were observed to stop completely. In several instances the symptoms seemed to occur abruptly but in general the change required from ten to fifteen seconds. The phenomenon was definitely observed in these four cases and definitely not observed in the others.

Two of these four subjects, during the last stage of the hold, could no longer hear the seconds being called out. This corroborates the observations of Gellhorn and Spiesman (3). These workers demonstrated a marked reduction in hearing ability during anoxia and hypercapnia.

The data are not adequate to determine whether oxygen depletion, carbon dioxide accumulation or both are responsible for the apparent depressed state of the respiratory center in the four subjects. In a few instances an anoxia photometer[3] was attached to the subject's ear. This was the case during one of the unusually long periods of breath-holding (188 secs.) when the symptoms of distress seemed to disappear. At the termination of breath-holding in this trial the oximeter indicated an arterial

[3] Modified ear oximeter manufactured by Coleman Company, Maywood, Illinois.

oxygen saturation of fifty-seven percent. If it can be assumed that the oximeter gives a reasonable approximation of the actual oxygen saturation, anoxia may conceivably be responsible for the phenomenon. However, relatively high concentrations of carbon dioxide are also known to depress the respiratory center (1, 5, 10). Unfortunately the carbon dioxide in the arterial blood or in the alveoli during breath-holding was not determined in these cases.

Schneider (15, 17) expressed the opinion that it is "practically impossible" for a subject to hold his breath until he becomes unconscious. Possibly the inherent or trained capacity to drive one's self to carry on under such conditions is present to a greater extent in physical education majors or individuals with a history of participation in sports. Of course, increasing the intrathoracic pressure as was done in this study would tend to bring on unconsciousness sooner.

Summary and Conclusions

An analysis-of-variance experimental design was used to study the practice effects of breath-holding before exercise, and after one, two, and five minutes of stepping, and also the effect of the duration of moderate exercise on breath-holding times. Twenty-two men students majoring in physical education were used as subjects. Each subject repeated all four breath-holding tests three times. Breath-holding was done on the flarimeter against the equivalent of 20 mm. Hg pressure with both orifices closed.

On the basis of the results presented the following conclusions appear justified.

1. Roughly fifty percent improvement may be expected in breath-holding time with a moderate amount of practice (three trials). This is true when the breath-holding tests are preceded by moderate exercise as well as when no exercise is taken.
2. Moderate exercise taken before breath-holding decreases the time the breath is held but the *duration* of the exercise is not related to the breath-holding time in a simple proportion as appears to be true for the *intensity* of exercise (14). Increasing the duration of moderate exercise has progressively less effect on breath-holding ability.
3. The four breath-holding tests employed do not measure precisely the same qualities.
4. It is possible for some individuals to hold their breath against 20 mm. Hg pressure until they become unconscious. In these subjects a point is reached during breath-holding when the respiratory center is no longer strongly stimulated.

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16. ———, "A Record of Experience with Certain Physical Efficiency and Low Oxygen Tests," *American Journal of the Medical Sciences*, **161**: 395–407, March, 1921.
17. ———, "Respiration at High Altitudes," *Yale Journal of Biology and Medicine*, **4**: 537–50, March, 1932.
18. SIMONELLI, G. AND G. FERRI, "Problemi di fisiologia Applicata alla Difesa chimica: L'Apnea volontaria," *Archivio di Fisologia*, **36**: 205–55, July 30, 1936.
19. TUTTLE, W. W., "The Effect of Weight Loss by Dehydration and the Withholding of Food on the Physiologic Responses of Wrestlers," *Research Quarterly*, **14**: 158–66, May, 1943.
20. WELLS, P. V., "The Flarimeter: A Clinical Instrument for Testing Circulatory Fitness," *Review of Scientific Instruments*, **1**: 332–40, June, 1930.

Learning To Juggle: I. A Study To Determine the Effect of Two Different Distributions of Practice on Learning Efficiency

CLYDE G. KNAPP
University of Illinois
W. ROBERT DIXON
University of Michigan

PRACTICE is one of the key conditions which must be considered in learning motor skills. This condition may be viewed in the light of at least seven variables whose influence seems to determine the amount of benefit derived from practice: 1) duration of the practice session; 2) length of the rest period between practice sessions; 3) practice method; 4) speed of movement during practice; 5) characteristics of the learner; 6) activity of the learner during the time between practice periods; and 7) complexity of the skill. These and other variables are the subject of much research by those interested in performance improvement.

Since practice does play such a prominent role in the learning of motor skills, it is essential that those charged with teaching these skills have a thorough understanding of the role played by the above mentioned variables during practice. The present study is concerned chiefly with the first two of these, specifically, duration of and the rest between practice periods. How long should a practice session be? How much time should elapse before the session may be repeated for the greatest efficiency? The earlier research on these questions was planned so as to identify the separate effect of each of the two variables. Thus, an experiment would be designed to measure the effect of different lengths of practice periods by maintaining a constant amount of rest between practice sessions and changing the length of the practice. By reversing the above arrangement the effect of different amounts of interpractice rest was studied.

As research on these two variables has continued it has become increasingly clear that there is a relationship between them. Travis, who used a manual pursuit oscillator to study motor learning, states that "the length of the practice periods and the length of the interpractice rest are fundamentally related."[1] He infers that a longer practice period must be followed by a longer rest period for efficient learning. More recently Nance has found distributed paced practice superior to massed

[1] Roland C. Travis. "Length of the Practice Period and Efficiency in Motor Learning," *Journal of Experimental Psychology*, XXIV (March 1939) 339–45.

unpaced, distributed unpaced, and massed paced practice. He adds that "it is probable that the superiority of distributed practice is based upon the magnitude of the work-rest ratio and not upon absolute length of trial or rest taken separately."[2] Further evidence of the interrelationship between practice and rest may be found in the study by Spence, Buxton, and Melton.[3] As reported by Nance,[4] these investigators used four different distributions of practice to measure learning on the S. A. M. Complex Coordination Test. At the end of the work period all the groups using distributed practice were superior to the continuous group. However, the group using the shortest work-rest ratio was *not* the most superior. Dore and Hilgard also emphasize the relationship when they state, "the optimum distribution of practice obviously lies somewhere between that overcrowding which disrupts practice and that separation which allows a loss of previous gains before practice is resumed."[5]

The present writers were interested in testing the inference made by Travis that longer work periods should be followed by longer rest periods for efficient learning. Would such an arrangement be as efficient as a shorter work-rest distribution? Incidentally, many persons inadvertently adopt the longer work-rest distribution when learning motor skills; they are unwilling or unable to practice regularly and attempt to compensate by engaging in long practice sessions with several days to a week intervening. We wanted to find an experimental situation which would employ a type of coordination closely associated with many sports activities and which would permit easy demonstrations to students. The motor skill of juggling was finally selected as a learning situation which would meet these requirements. Juggling or ball-tossing was a favorite subject of study among early psychological researchers, Swift[6] and Pederson[7] being two who reported using this technique. They were primarily concerned with discovering the nature of the learning curve.

Procedure

Selection of Subjects. The subjects in the experiment were University of Illinois male seniors majoring or minoring in physical education. All of these men were doing student teaching in physical education.

Prior to the establishment of the experimental groups the number of

[2] R. Dale Nance. "The Effects of Pacing and Distribution on Intercorrelations of Motor Abilities." Unpublished Ph.D. Dissertation, State University of Iowa, June 1946.

[3] K. W. Spence, C. E. Buxton, and A. W. Melton. "The Effect of Massing and Distribution of Practice on the S.A.M. Complex Coordination Test." Civil Aeronautics Authority, Division of Research, December 1945, No. 53.

[4] R. Dale Nance. *Op. cit.*

[5] Leon R. Dore and Ernest R. Hilgard. "Spaced Practice and the Maturation Hypothesis," *Journal of Psychology*, IV (October 1937), p. 245–59.

[6] Edgar James Swift. *Mind in the Making.* New York: Charles Scribners Sons, 1909. viii + 329.

[7] Joseph Pederson, "Experiments in Ball-tossing: The Significance of Learning Curves," *Journal of Experimental Psychology*, II (June 1947), 178–224.

potential subjects was cut down by eliminating those who already possessed some juggling skill. In a pre-test, consisting of three trials, each subject tried to juggle three paddle tennis balls. Subjects who made five or more consecutive catches on any one of the three trials were eliminated from the experiment.

By means of random selection, the subjects were placed in *two* groups of 35 men each. After the composition of the groups had been established, the backgrounds were studied to determine whether the groups were equal in athletic experience and competence. In terms of such criteria as high school letters, college squads, and college varsity letters the groups were well matched.

Practice Preparations and Instructions. An effort was made to orient the subjects in the juggling situation. For example, several demonstrations of juggling were presented. Also, a number of rules and suggestions were given to each subject. These were mimeographed and time was spent in class discussion of the items until each subject felt he fully understood how to proceed. The following is a duplicate of the above mentioned mimeographed material:

A. Rules
   1. Only the whole method is permissible.
      a. You may not practice the hand movements without using balls.
      b. You may not practice the toss and catch using less than three balls.
   2. During a juggle at least one ball must be in the air at all times. If two balls touch a hand simultaneously the count must stop.
   3. Time and distribution of practice sessions, as stipulated for your group, must be followed exactly.

B. Suggestions
   1. Start with two balls in the dominant hand.
   2. Toss and catch the balls with rhythmical movements.
   3. In tossing let the ball leave the hand approximately in front of the chin with the head facing forward.
   4. Toss the ball to a height approximately equal to the top of your head.
   5. Toss the ball so that it may be caught about six inches to the left, or right, of the sternum line at a height slightly above the belt.
   6. Toss the ball to the inside of the ball about to be caught.
   7. Watch the balls with a minimum of eye movement.
   8. Concentrate on your task.
   9. Relax.

Group I was instructed to practice juggling the three balls for *five minutes each day*, while Group II was to practice for *fifteen minutes every second day*. Subjects recorded the greatest number of consecutive catches made in each practice schedule until they had succeeded in making 100

consecutive catches. This was the criterion used to measure when the subject had learned to juggle. It will be noted that the above arrangement provides two different ratios of practice and rest: 1) a short practice followed by 24 hours rest; 2) a longer practice followed by a longer rest. This should permit us to ascertain whether or not the longer practice-rest ratio is as conducive to learning as the shorter ratio.

Results

Table 1 presents a comparison of the average time required by the subjects in the two groups to learn to juggle. The mean score for Group I was 69.86 minutes and for Group II was 125.80 minutes. The significance of the difference between the two means was computed by using the Student-Fisher t test. A t value of 3.84 was derived which is significant at the 1 per cent level of confidence.

It will be noted that there are 35 subjects reported for Group I and only 31 subjects for Group II. Actually there were 4 more subjects in Group II when the experiment started, however, 4 gave up after they had spent

TABLE 1

Comparison of the five minute daily and the fifteen minute every second day groups in terms of the mean number of minutes required to learn to make 100 consecutive catches in juggling three balls

GROUP	N	MEAN	σ	DIFF	$\sigma_{diff.}$	t	P
Five minute daily	35	69.86	48.20	55.94	14.98	3.84	< 01
Fifteen minutes on alternate days	31	125.80	68.60				

over 200 minutes in trying to learn. Hence, their scores would not make the difference between the performances of the two groups less significant.

Inspection of the individual learning times of the subjects revealed wide differences. The range in Group I was from 19 minutes to 210 minutes while in Group II it was from 40 minutes to 270 minutes. The fastest subject in Group I learned more than eleven times as fast as the slowest subject in that group. Such wide variation in individual performance within these groups would seem to be as noteworthy as the difference between the average group performances.

Discussion of Results. The magnitude of the difference between the average performances of the two groups was startling to the authors. Whereas a substantial amount of individual variation might have been predicted, it is doubtful whether anyone would have forecast such a significant difference between the average group scores. The longer practice-rest ratio was certainly not as conducive to efficient learning as the shorter ratio. But, it should be noted that the subjects using the longer ratio learned to juggle in only 8 plus periods while it took the subjects

using the shorter ratio 13 plus periods to reach our criterion. On the basis of these data it seems probable that one can compensate for missed practice sessions by engaging in longer work periods, at least as far as the number of such periods is concerned. Nevertheless, this procedure is relatively inefficient in terms of the amount of actual practice time.

To what shall this difference in learning rate be attributed? If Franklin and Brozek's[8] evidence relating to the ineffectiveness of changing the rest interval is accepted then the length of the work period must be the important factor. However, Travis[9] has equally good evidence which indicates that the length of the rest interval does play an important role in motor learning. Just why the shorter work-rest sessions facilitated more rapid learning remains a moot question. Possible determiners might be found in several of the concepts most frequently used to explain such results. Fatigue may have played a part. Motivation also undoubtedly entered the picture since the subjects' attitudes during the longer work periods were noticed to change. Frequently the men became tense, poorly coordinated, and irritated because of their inability to master the skill. Perhaps, too, the shorter work-rest ratio permitted differential forgetting to operate more effectively.

Attention should be directed to the usefulness of the demonstration experiment technique as a teaching procedure. It may confidently be stated that the men learned much more than just juggling during the course of the experiment. For example, a constructive attitude toward experimentation and research was developed by most of the students. Numerous comments were made to the effect that "maybe there is something to this research business after all." Certainly there was noticeable improvement in the interest and zest with which the students approached the study of teaching methods.

Summary and Conclusions

The present study has described a demonstration of the effect of two different practice-rest conditions in learning to juggle. College seniors in physical education were selected as subjects. After eliminating those who were able to make five or more consecutive catches on a pre-test, the men were placed in one of two groups by means of random selection. The groups possessed an equivalent amount of athletic experience, as measured by high school letters and college varsity letters. The subjects in Group I practiced juggling 3 paddle tennis balls for five minutes daily until they were able to make 100 consecutive catches, while Group II practiced the same skill for fifteen minutes every second day.

[8] Joseph C. Franklin and Josef Brozek, "The Relation between Distribution of Practice and Learning Efficiency in Psychomotor Performance," *Journal of Experimental Psychology*, XXXVII, No. 1 (February 1947), 16–24.

[9] Roland C. Travis, "Effect of the Length of the Rest Period on Motor Learning," *Journal of Psychology*, III (January 1937), 189–94.

The data from this demonstration indicate that: 1) the five minute daily practice sessions facilitated more rapid learning than the fifteen minute every second day sessions, one minute of practice in Group I proving to be as effective as 1.80 minutes in Group II; 2) fewer practice periods will be needed to learn a motor skill when a longer work-rest distribution is used; and 3) wide individual differences may be expected in the learning of motor skills even among subjects who have had wide experience in related skills.

Guide to Authors

IN line with the overall goal of making Association publications yield the greatest value to the individual and profession, the following is a yardstick for the preparation of research manuscripts. The information as spelled out below recognizes general techniques being employed by research publications of similar nature. Copy prepared on this basis looks forward to the establishment of a standard style for all Association research studies.

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Manuscripts should be sent to the Editor who will see that each one is read by at least three members of the Board of Associate Editors. The Editor will advise the author as to the suitability of the paper or the desirability for revision. Papers are not judged by arbitrary standards of length but on their content of new research results in the field of physical education, health education, and recreation, presented with the greatest brevity compatible with scientific accuracy and clarity.

Since three members of the Board of Associate Editors review an article it is requested that at least two copies of the manuscript (the original and a clear carbon) be submitted in order to facilitate reviewing. One copy of the article should be retained by the author for checking against galley proofs.

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The sheets of manuscript should be kept flat and fastened with clips which can be removed easily. The pages of the typewritten copy should be numbered consecutively in the upper right hand corner.

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A uniform style should be maintained in writing citations. Quote titles of chapters and articles. Italicize [underscore] names of books and publications.

A uniform sequence of data should be observed. The preferred sequence is: Author's name—title of article or chapter—name of book or publication —volume number—page numbers—year date.

EXAMPLE OF FOOTNOTE

[3] H. Harrison Clarke. *The Application of Measurement to Health and Physical Education*. New York: Prentice-Hall, Inc., 1946. p. 240.

EXAMPLE OF REFERENCES APPEARING AT END OF ARTICLE

1. Ogden, Jean, and Jess Ogden. *Small Communities in Action*. New York City: Harper & Brothers, 1946. (books)
2. Deaver, G. G. Exercise and heart disease. *Research Quarterly*, **10**:24–34, 1939. (periodicals)

or

1. Deaver, G. G., "Exercise and Heart Disease," *Research Quarterly* **10**:24–34 (1939). (periodicals)

Use of Numbers

Use figures for all definite weights, measurements, percentages, and degrees of temperature (for example: 2 kgm., 1 inch, 20.5 cc., 300°C.). Spell out all indefinite and approximate periods of time and other numerals which are used in a general sense (for example: one hundred years ago, about two-and-one-half hours, seven times). Spell out numbers through nine; arabic figures for 10 and over.

Abbreviations

The metric system being in universal usage, standard abbreviations should be used whenever the weights and measurements are used with figures, i.e., 10 kgm., 6.25 cc., etc. The forms to be used are: cc., kgm., mgm., mm., l., and m. *Gram* should be spelled out in all cases to avoid possible confusion with grain. All obscure and ambiguous abbreviations should be

avoided. No abbreviations of English weights and measures should be used. Preserve uniformity in all abbreviations.

Tables

Each table should have a descriptive heading and should be specifically referred to in the text by number, *e.g.*, "Table 10," etc., never as "the above table" or "the following table." Number tables from 1 up for the entire manuscript, using Arabic numerals. For graphic presentations, use roman numerals. Percent should be one word. Use percent sign (%) in tables or when it appears in parenthesis in text.

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Arrange article so as to indicate relative values of heading and subheadings. Usually four gradations are sufficient (a) article title, (b) first subhead appearing in boldface aligned left on page, (c) second subhead (if necessary) appearing in small caps aligned left on page, (d) third subhead, to appear in italic (underscored in manuscript), not centered, but run in at the beginning of the paragraph or section.

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Illustrative material is of two types: pen and ink drawings, which are reproduced by the line engraving process; and photograph, wash drawings, stipple drawings, in short anything containing shading, which are reproduced by the halftone process.

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Halftones are treated as plates and should be so designated. Frequently, several halftones can be grouped to form an attractive full page plate, in which case they should be numbered consecutively, in Arabic numerals, as figures of the plate. Photographs should be in the form of clear black and white prints on glossy paper. Care should be taken to see that they cannot

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Mark on proof the errors that are discrepancies in transcription from the manuscript in *red* ink. Mark any changes from copy in *black* ink. The two classes of error are handled by two different operators.

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Continued from May Quarterly

RESEARCH ABSTRACTS

Prepared by the Research Abstracts Committee of the Research Section, Carolyn W. Bookwalter, Chairman

Anatomy and Physiology

37. SULLIVAN, WALTER EDWARD, OTTO AXEL MORTENSEN, MERYL MILES, AND LAURENTINE STEENSLAND GREEN. Electromyographic studies of M. biceps brachii during normal voluntary movement at the elbow. *Anat. Rec.*, v. 107, no. 3, July, 1950.

Action potentials were recorded from M. biceps brachii of normal subjects during voluntary movements of the elbow joint. A modified electrocardograph and surface electrodes were used. A standard set of movements was performed: 1) elbow flexion (acceleration), forearm supine and prone; 2) elbow extension (negative acceleration), forearm supine and prone; 3) hold (zero acceleration), forearm supine at 135°, 90°, 45° flexion. Film speed was 2.5 cm a second. Loads of zero, 1.0 kg and 2.0 kg were used. Repeated recordings from one subject at the same sittings were usually similar. Repeated recordings from one subject with intervals of weeks intervening usually, but not always, gave similar patterns. Action potentials tended to be higher on the earlier trials than on the later ones. When two or more subjects were studied under similar conditions the recordings were similar or different in pattern and/or amplitude. The variations in pattern and amplitude were assumed to represent differences in the use of the muscle during a given movement. Potentials of lower amplitude were recorded from both parts of the muscle when the movement was performed with the forearm in the prone position and, in general, from the short head under all conditions studied. —*The Wistar Institute.*

38. FINKLER, RITA. Functional sterility and amenorrhea. *Mod. Med.* **18:** 5, 1950.

Dr. Finkler has found irradiation slightly preferable to hormone therapy in cases of pituitary-ovarian hypofunction, i.e., for functional sterility and amenorrhea, X-ray therapy obtained desired results more quickly and slightly more often than hormone therapy. After X-ray therapy on women patients desiring children, 35% conceived after medication. Menstruation was restored in 46% of those receiving X-ray therapy *vs.* 41% under medication.—*A. C. Kelly.*

39. HORVATH, STEVEN M. AND STELLA Y. BOTELHO. Orthostatic hypotension following hot or cold baths. *J. Applied Physiol.*, **1(8):** 586–596, 1949.

Twenty-two subjects, including 9 males and 13 females, after preliminary testing were subjected to hot and cold baths of either 18° or 40° ± 0.2°C and following immersion, returned to the ballistocardiograph where stroke volume and cardiac output were determined in supine and erect positions. Passive alteration of posture from supine to erect (70°) was accompanied by an elevated heart rate and a reduced stroke volume. Cardiac output was increased slightly in those individuals who later developed abnormal responses to change in posture following heat stress, but was lowered in those who were able to tolerate the shift without difficulty. Approximately one-half of subjects developed orthostatic hypotension following immersion in hot bath for 20 min. This result seems to be caused by a combination of pooling of blood and fluid in the extremities, and a failure of the presso-sensible reflexes to increase cardiac output. Erect posture was maintained with greater ease and reduced cardiovascular demands following a cold bath.—*J. M. Boutwell and P. V. Karpovich.*

40. Meshchan, I., J. Scruggs, Jr., and J. Calhoun. Spinal fracture from electric shock therapy. *Mod. Med.* **18:** 13, 1950.

In a study of 212 male mental cases receiving electric shock treatment, it was found that 35.4% received injury to vertebral bodies. In the 75 injured patients, the average number of fractures each was 2.56. The 3rd, 4th and 5th dorsal were predominantly affected. Four fifths of the fractures occurred in the first 5 treatments.

Use of curare reduced occurrence of fractures, but as it is a dangerous drug, recommendation was made that its use be confined to cases showing anterior narrowing of bodies. Cases of this type were found to have a higher percentage of fractured bodies (but not the narrowed ones themselves).—*A. C. Kelly.*

41. Miller, A. T., Jr., and J. O. Miller, Jr. Renal excretion of lactic acid in exercise. *J. Applied Physiol.*, **1(8):** 614–618, 1949.

Blood lactate concentration and total urine lactate during exercise and recovery were determined in 72 experiments on 2 subjects. Apparent renal threshold is approximately 60 mg.%. Lactate clearance is 1 to 2 ml/min. at rest and rises to 15 to 20 ml. min. in exhausting exercise. Urine lactate may be considered only as an approximate index of total lactate production in exercise.—*P. V. Karpovich.*

42. Ramsey, Glenn V. Sexual growth of Negro and White boys. *Human Biology*, **22:** 146–49, 1950.

The data were secured by the personal interview technique as reported by 37 Negro boys and 286 White boys. The Negro boys ranged in age from 11 to 16 years; the White boys from 10 to 20 years, 85 per cent from 12 to 16.

The results indicate very little racial differences in the three measures of sexual growth. The median age reported for first ejaculation by Negro boys was 13.8 years and for Whites was also 13.8; for the first appearance of pubic hair for the Negro group was 13.3, for the White group, 13.6; and the first recognition of voice change was 13.7 for the Negro males and 13.4 for the White males. These data are in close agreement with those provided by Kinsey et al.—*D. B. Van Dalen.*

43. Roswit, B., J. Sorrentino, and Rosalyn Yalow. The diagnostic role of radioactive isotopes. *Mod. Med.*, **18:** 6, 1950.

As organized for diagnostic work, a radioisotope unit consists of pathologist, radiologist, biochemist, medical internist, hematologist, and radioisotope physicist. Fundamental research indicates that such units may become an important part of service in hospitals. The authors discuss the diagnostic role of seven of these radioisotopes which already have proved valuable to medicine.—*A. C. Kelly.*

44. Sandow, A. Muscle. *Ann. Rev. Physiol.*, **11:** 297–334, 1949.

Primary interest is in studies concerned with the fundamental problems of contraction of skeletal muscle. References are cited under the headings of Mechanics, Myothermy, Bioelectricity and Excitability, Ultrastructure, Enzymology, and Mechanism of Contraction, and Miscellaneous.—*G. M. Gloss.*

45. Spiro, Robert K., Evan R. Goltra, and John S. Thompson. Experiments with the Eve method of artificial resuscitation. *J. Applied Physiol.*, **1(4):** 285–297, 1949.

A series of 5 experiments performed to determine the efficiency of the method. Results show the method provides adequate lung ventilation. Rocking tidal air values were greater than normal at rest by 50%. Method does not cause discomfort to patient. Preferred rate of rocking is 12/min. and maximum angle of 30° tip. This rocking procedure raises cardiac output as calculated by Erlanger-Hooker formula (product of pulse pressure and pulse rate).—*J. M. Boutwell and P. V. Karpovich.*

46. Walker, A., and T. Hopple. Brain tumors in children. *Mod. Med.* **18:** 5, 1950.

Because of the brain's compensatory power, symptoms of cranial tumors in chil-

dren are frequently not noticed until the tumor is large enough to produce "intracranial hypertension by mass blockage of ventricular fluid or both." The general prognosis is not good, but cerebellar astrocytomas and some cerebral tumors may be removed successfully.—*A. C. Kelly.*

Anthropometry

47. Dupertuis, Clarence Wesley. Anthropometry of extreme somatotypes. *Am. J. Phys. Anthrop.*, n.s. v. 8, no. 3, (September, 1950).

Anthropometric measurements taken on 30 somatotypes showed ectomorphs to be vastly different from endomorphs and mesomorphs. Significant differences of means between the latter two groups occured mainly in trunk diameters and circumferences.

Results indicated that head and face measurements and body and limb lengths failed to differentiate well between the three groups of extreme somatotypes. Lateral and anteroposterior diameters of the trunk, and circumference measurements showed greater differences. They were not so successful, however, as Sheldon's needle point measurements on the photographs for discriminating between morphological types. The conclusion is reached that anthropometric measurements on the living are only moderately successful in demonstrating anatomical differences between extreme somatotypes and are of questionable value in differentiating between the midrange and closely related somatotypes.—*The Wistar Institute.*

48. Garn, Stanley Marion, and Menard M. Gertler. An association between type of work and physique in an industrial group. *Am. J. Phys. Anthrop.*, n.s. v. 8, no. 3, (September, 1950).

A number of recent studies have demonstrated associations between body-build on the one hand and interests, attitudes and choice of professions on the other hand. The present study was concerned with the physical differences between a factory group in Cambridge, Massachusetts, and 20 members of that group engaged primarily in research. In somatotype components the research group was significantly less endomorphic, less mesomorphic and more ectomorphic. The modal research somatotype was ectomorphic as compared to a bimodal endomorphic—mesomorphic distribution for the factory group, the height-weight index, and the majority of the anthropometric measurements confirmed the impression of greater linearity in the research group. Twelve out of 31 measurements and indices showed significant differences in the direction names; these included face measurements and indices as well. It was shown that the greater linearity of the research group could not be attributed to age or education, but within the limits of the study, seemed to represent a predilection of ectomorphic physiques for non-routinized, non-aggressive occupations, such as research.—*The Wistar Institute.*

Education

49. Bloch, H. A. Alcohol and American recreational life. *Amer. Scholar*, **49**: 54–66, 1948.

The author concludes: despite reform movements and efforts to modify the country's drinking habits, our outlook relative to this entire problem is so entrenched, due to historical necessity and established recreational patterns, that success in transforming our habits is rather dubious . . . mass reformation of drinking habits suggests the need for concerted attack upon the personality-producing tensions in American life and the modification of certain phases of the entire recreational patterns reflected in our culture.—*G. M. Gloss.*

50. Petersen, Jane M. An Illinois group activity test. *Publ. Personnel Rev.*, **10**: 222–225, 1949.

A test for selecting Recreation Aides. Test is a group activity situation in which the candidates participate in games, folk-dancing, and athletics. The technique appears to have face validity and it has been very well received.—*G. M. Gloss.*

51. SCHREK, ROBERT. A graphic method for comparing percentages and means of control and experimental groups. *Human Biology*, **22:** 65–70, 1950.

A special graphic method was developed to facilitate the presentation of a comparison of experimental and control groups with respect to percentages and means. This graph simplifies the presentation of statistical import to readers who are not statistically trained.—*D. B. Van Dalen.*

Health and Safety

52. KAMM, A. Swimming as an active therapy. *Ment. Hyg. N. Y.*, **33:** 417–423, 1949.

Methods and techniques for training the mental patient how to swim and to obtain therapeutic benefits from this activity. The author shows that "The achievement of results depends partly on facilities and equipment, but primarily on teaching methods and the leadership available . . ."—*G. M. Gloss.*

53. TUTTLE, W. W., MARJORIE WILSON, AND KATE DAUM. Effect of altered breakfast habits on physiologic response. *J. Applied Physiol.*, **1(8):** 545–559, 1949.

Six women subjects were subjected to controlled breakfast habits and twice a week performed on the bicycle ergometer between 11:00 and 12:00 noon to determine maximum work output. Omission of breakfast caused decrease in maximum work output, increase both in simple and choice reaction time, and increase in tremor magnitude. Coffee alone caused a decrease in maximum work output, and choice reaction time, and an increase in tremor of an outstretched arm. Light breakfast caused a significant improvement of maximum work output and choice reaction time, and a decrease in tremor magnitude. Experiment showed that there are considerable individual differences in response to altered breakfast habits. A direct comparison of the physiologic responses during light and heavy breakfast periods could not be made because the breakfast period of coffee only occurred between heavy and light breakfast.—*J. M. Boutwell and P. V. Karpovich.*

54. WEEK, ERLING FINCH, AND FRANK JEAN SEVIGNE. The utilization of vitamin A alcohol, vitamin A acetate and vitamin A natural esters by humans. *J. Nutrition*, v. 40, no. 4 (April, 1950).

Blood serum vitamin A levels were used as the criterion for determining the relative utilization of the alcohol, acetate and natural ester forms of vitamin A by 18 men and 7 women, after administration of 134,000 μg of the vitamin contained in 50 gm of margarine.

For the male subjects, vitamin A alcohol showed greater biological efficacy than vitamin A acetate which, in turn, was superior to the natural ester forms. Vitamin A alcohol produced a greater biological response than vitamin A acetate for the female group; however, comparison of the alcohol form with a distilled natural ester preparation showed no significant difference in utilization. The experimental data were subjected to analyses of variance, and the statistical significance of a great part of the data was established. The addition of 300 mg of tocopherols to the vitamin A alcohol supplements had no appreciable effect on vitamin A absorption.

After ingestion of high dosages of the vitamin, the increased vitamin A in the blood serum was present as the ester, irrespective of the chemical form of the vitamin administered in the supplement.—*The Wistar Institute.*

55. ZIMMERMAN, F., AND BESSIE BURGEMEISTER. The effect of glutamic acid on borderline and high-grade defective intelligence. *N. Y. State J. of Med.*, **50:** 6, 1950.

Eighty-five patients, borderline, and some at upper end of defective range, 4 to 18 years of age, received glutamic acid therapy for one year. Results showed that glutamic acid was effective in raising the intelligence level in 66% of cases. Progress was less pronounced in children with severe behavior problems and in those with gross cerebral pathology.—*A. C. Kelly.*

Psychology

56. GAGNE, R. M., KATHERINE E. BAKER AND HARRIET FOSTER. Transfer of discrimination training to a motor task. *J. Exp. Psychol.* **40:** 314–328, 1950.

A control group of 28 men made 60 responses each in a motor learning situation that required S to hit one of 4 switches in response to one of 4 signal lights, the stimulus and response being identified by both position and color. One experimental group of 56 Ss received 30 trials on color discrimination of the signal lights while another 56 Ss practiced on position only. Both experimental groups then did the motor problem involving both color and position. The preliminary training with either discrimination resulted in considerable positive transfer to the motor task. The two types of training were equally effective in speeding up response time, but training in color discrimination, which was the more difficult discrimination, was more effective in reducing error. —*F. Henry.*

57. KANJILAL, P. The emergence of natural muscular rhythm: a preliminary report. *Indian J. Psychol.*, **19:** 78–85, 1944.

A brief report of a rhythmic experiment in which six boys and six girls were asked to press a rubber bulb continuously until told to stop. Definite rhythmic patterns emerged in all cases with marked individual differences in rhythmic types. An appendix presents detailed data.—*G. M. Gloss.*

58. RIOPELLE, A. J. Psychomotor performance and distribution of practice. *J. Exp. Psychol.* **40:** 390–395, 1950.

The complex reaction time of 20 college students making 40 trials massed in one day was compared with that of 23 students who practiced at 4 trials per day for 10 days. The distributed practice was considerably more effective, the degree of superiority increasing throughout the learning period. For massed practice, initial scores correlated only .03 with gains compared with .31 for distributed practice.—*F. Henry.*

59. SWEIGARD, LULU E. (New York U.) Psychomotor function as correlated with body mechanics and posture. *Trans. N. Y. Acad. Sci.*, **11:** 243–248, 1949.

Individuals have a persistent posture pattern which influences movement activities developed mainly from conditioned neuro-muscular action. Mental activity involving thought of movement is the most efficient re-conditioning technique. Eight "lines of action" isolated by the author may be used in reconditioning poor posture. —*G. M. Gloss.*

60. WATERS, R. H. AND J. G. REITZ. The role of recency in learning. *J. Exp. Psychol.*, **40:** 254–259, 1950.

The validity of 'recency' as a principle of learning has been denied on both theoretical and experimental grounds. In the present experiment, 10 Ss served as a control group in the learning of a raised-wire finger maze, and 10 Ss shifted from right to left hand repeatedly as well as shifting posture from standing to sitting during the last 5 to 15 trials. This did not alter the amount of learning, its variability, or successful prediction of later choices based on 'recency.' Choices made at any particular choice point predicted the next choice at that point with an accuracy of 70%. Since the Ss had a set to learn, were learning and continued to learn in spite of shifts in bodily orientation, it was concluded that successful prediction in terms of 'recency' is a function of 'what the organism is trying to do'—thus 'recency' is not a causal law, but a condition that *allows* learning to operate.—*F. Henry.*

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Di Napoli, Frank, South Bend High School, South Bend, Washington.
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Drew, A. Gwendolyn, Physical Education for Women, Washington University, St. Louis 5, Missouri.
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Dutton, Elizabeth A., Utah State Agricultural College, Logan, Utah.
Elliott, E. S., 17 East 89th Street, New York City 28.
Espenschade, Anna, Hearst Gymnasium, University of California, Berkeley 4, California.
*Evans, Ruth, 326 Forest Park Avenue, Springfield, Massachusetts.
Fontaine, Carnie B., Route 2-Box 34 Canby, Oreg.
Fox, Margaret G., State University of Iowa, Iowa City, Iowa.
Francis, Robert J., University of Wisconsin, Madison 6, Wisconsin.
Frankel, Mrs. Elkan F., 4002 Muirfield Road, Apartment B, Los Angeles, California.
French, Esther, Illinois State Normal University, Normal, Illinois.
Friermood, Harold T., 51 Clifford Avenue, Pelham, New York.
Fuller, Jane M., St. Lawrence University, Canton, New York.
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Gates, Grover A., 835 Hampton Way, Fresno, California.
Gercke, Claudia Ann, 450 Camden Avenue, Morrestown, New Jersey.
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Gray, Miriam, Illinois State Normal University, Normal, Illinois.
Greene, Margaret D., WPE 140, University of California, Los Angeles 24, California.
Griffin, Robert P., Florida A & M College, Tallahassee, Florida.
Gugisberg, Mercedes, University of New Mexico, Albuquerque, New Mexico.
Hamilton, Alberta, Mt. Vernon Township High School, Mt. Vernon, Illinois.
Hansma, Jack, E., Colorado State College of Education, Greeley, Colorado.
Hazelton, Helen W., 212 Varsity Apartments, West Lafayette, Indiana.
Hein, Fred V., 535 North Dearborn Street, Chicago 10, Illinois.
Hepp, Frank, Royal Hungarian College of Physical Education, Gyroiut 13, Budapest, Hungary.
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Langston, Dewey F., Univ. of Arkansas, 346 Arkansas Ave., Fayetteville, Ark.
Langton, Clair V., Oregon State Agricultural College, Corvallis, Oregon.
Lapp, V. W., 2234 Cotner Boulevard, Lincoln, Nebraska.
La Tourette, Charlotte, Route No. 4, Athens, Ohio.
Lee, Mabel, University of Nebraska, Lincoln, Nebraska.
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Luehring, F. W., 435 Riverview Road, Swarthmore, Pennsylvania.
MacGregor, John M., 101 Chandler Court, Williamsburg, Virginia.
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Manley, Helen, Public Schools, 6701 Delmar Blvd. University City, Missouri.
*Maroney, Frederick W., Brooklyn College, Brooklyn, New York.
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Mauricio, Frater A. J., Mauricio College of Physical Education, 88 Caine Road, Hong Kong, China.
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*McCurdy, Mrs. J. H., 79 Lawn Avenue, Middletown, Connecticut.
McNeely, Simon A., Specialist in Health and Physical Education, U.S. Office of Education, Washington, D. C.
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Metcalf, T. N., 5640 University Avenue, Chicago, Illinois.
*Meylan, George, Casco, Maine.
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Mitura, Margaret A., Woodland, Wash.
Mohr, Dorothy R., University of Maryland, College Park, Maryland.
Moore, Rodgers L., Box 823, Porterville, California.
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Mullen, George D., State Teachers College, Plattsburg, N. Y.
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Neilson, N. P., University of Utah, Salt Lake City, Utah.
*Nordly, Carl L., University of Minnesota, Minneapolis.
Norris, J. Anna, 1429 East River Road, Minneapolis, Minnesota.
Noyes, Elizabeth, Bennett Junior College, Millbrook, New York.
O'Gara, Carl M., University of California, 405 Hilgard Ave., Los Angeles 24, California.
Olds, Lloyd W., Hurron Apartments, 921 Westcross Street, Ypsilanti, Michigan.
Olmo, Florence, 108-16 164th Street, Jamaica 5, New York.
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*Savage, C. W., 310 Reamer Place, Oberlin, Ohio.
Schmid, Thomas, 808 9th Avenue S., St. Cloud, Minnesota.
Schnell, H. W., College of Physical Education, Health, and Athletics, University of Florida, Gainesville, Florida.
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Schuyler, Gretchen, Sargent College, 6 Everett Street, Cambridge 38, Massachusetts.
Scott, M. Gladys, State University of Iowa, Iowa City, Iowa.
Sellers, Dorothy G., 1005½ 26th Street, North, St. Petersburg, Florida.
Shaw, John H., Department of Physical Education, Syracuse University, Syracuse 10, New York.
Siler, J. Granville, 204 Morgan Hway., Orinda, California.
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Stieler, Ida M., 1111 South Kentucky Avenue, Evansville 13, Indiana.
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